2.0 PROGRAM INFORMATION

2.1 Air Traffic Services Program Area Description

Mission

The purpose of Air Traffic Services (ATS) is to ensure the safe and efficient operation, maintenance, and use of the air transportation system today and to increase tomorrow's system safety, capacity and productivity. The ATS R&D program is an overt initiative to provide a structured, evolutionary improvement of services that keeps pace with the global growth in aviation. R&D within the program is intended to develop technology, practices, and procedures that ensure continued improvement in the delivery of air traffic services.

Intended Outcomes

The ATS R&D program is part of an integrated strategy to increase the value of the air traffic services delivered. It provides a vehicle for making long-term investments in improving services, procedures and infrastructure, as well as integrating new concepts and technology able to meet the increasing demands of safety, capacity, efficiency, and productivity. Human factors considerations are central to all outcomes of the program for a totally effective solution.

The ATS R&D program contributes to the performance outcomes contained in the Air Traffic Service Plan (2000-2002) as well as to the strategic goals of the Government Performance and Results Acts (GPRA). The program is also consistent with the goals delineated in the FAA Strategic Plan, Research and Acquisitions Performance Plan, and Regulation and Certification Performance Plan.

The ATS R&D program contributes to the four performance outcomes described below and represents increased value to the users of the system and the American public.

Improve Quality and Availability of Weather Information — Weather has a continual impact on the safety of aircraft in flight as well as the efficiency of operations throughout the National Airspace System (NAS). Weather and resultant decision making, factors in approximately 23% of all aviation accidents, annually cost the country an estimated $3 billion for accident damage and injuries, delays and unexpected operating costs. The ATS R&D program is striving to improve both the accuracy, display, and timeliness of weather information and the ability of controllers and pilots to use that information safely and efficiently. Aviation weather capabilities in the NAS must undergo major changes to improve decision making and to reduce the number of weather-related accidents. To achieve these ends, today's weather sensors must be networked to allow all NAS providers and users to receive the same weather information simultaneously.

The ATS R&D program is pursuing an aggressive schedule to develop and implement a variety of technologies that can improve the accuracy, timeliness, and usefulness of weather information in combination with extensive training for pilots and ATS personnel on the use of new weather systems.

Research is focused on increasing accurate aviation weather forecasts from their present one-hour "look-aheads" to providing reliable four-hour predictions of storms and fog. Related ATS research is currently collecting and analyzing data to demonstrate the capability of new weather technologies to decrease the rate of weather delays in the NAS.

Reduce Delays — Attested delays are traditionally used to measure ATM system efficiency. Delay occurs in the aviation system when an activity does not happen within the planned, expected, or scheduled time. Delays to commercial aviation are estimated to cost the airlines over $3 billion per year. The inconvenience of delays directly affects passengers in terms of missed flight connections and business meetings, and loss of personal time. But not all delays are avoidable. Adverse weather, for example, can close a runway or whole airport, making it impossible to land at the scheduled time.

Service improvements during the 2000-2002 timeframe will focus on Free Flight Phase 1 tools, airport expansion, and critical infrastructure

replacement programs. Airspace and airport capacity will be enhanced to improve throughput and allow aircraft to operate with minimal delay in congested areas.

Continuing to involve users in decisions affecting the flow of air traffic across the nation will reduce the impact of weather on flight schedules. While weather-related delays are harder to influence, the ATS R&D program is continuing to support Collaborative Decision Making and the implementation of automated detection and forecasting tools to mitigate the negative impact of these delays.

Improve System Predictability — System predictability allows users to plan and manage their resources efficiently. Most system users rely on schedules that define when aircraft takeoff and aircraft land. These schedules are central to the operations of commercial flights, driving crew scheduling, ground service operations, and other operational components. Near-term decisions such as scheduling and planning flights—as well as longer-term decisions such as fleet sizes, airframe types and hubbing options—are all impacted by day-to-day variation in NAS performance. Scheduled operations are highly dependent on total system predictability, and ripple effects of relatively small deviations from scheduled operations can cause widespread and drastic impacts.

The ATS R&D program is working toward increasing information flow to system users, a key ingredient to improved system predictability. Collaborative planning between ATS and all NAS users is a strategy being pursued during the 2000-2002 timeframe. As weather is a main contributor to the uncertainty in the ATM system, improvements are being undertaken to obtain and disseminate better weather products. These improvements will supply consistent information to pilots and controllers alike so that they can realize the same degree of situational awareness.

Improve System Flexibility — Measuring the flexibility of the ATM systems allows ATS to evaluate its own ability to permit users to adapt their operations to changing conditions. Users want the capability to optimize their operations in the face of objectives and constraints that can vary flight-by-flight and user-by-user.

ATC-preferred routes are important tools that help air traffic controllers to organize traffic flows around major airports and minimize conflict in congested airspace. These routes are generally not the most direct alternatives, and often differ significantly from the routes that pilots or flight planners would normally propose between two cities.

Due to the constraints of ATC-preferred routes, users sometimes experience inflexibility during the flight planning process, especially when planning flights along heavily traveled corridors. Flexibility in flight planning offers users significant benefits. Once an aircraft is airborne, the conditions for which a route and altitude were originally chosen may change. For example, winds may shift to make another route more desirable. The parameters that affect an optimal flight are highly dynamic, and ATS options must be equally flexible.

For increased flexibility of flight operations in the NAS, the ATS R&D program will continue to evolve its services toward the free flight concept of operations and work with aviation users in the review and redesign of the national airspace.

Program Area Outputs

The developmental outputs of the ATS R&D program vary in composition from operational prototype equipment to operational concepts, modeling and simulation studies, emergent technology evaluations, and procedures, standards, and guidance. Some specific examples of expected outputs for the ATS R&D program follow:

- Uplink of guidance information that will give aircraft and controllers the same situational awareness.
- Timely delivery of high-resolution information for icing, winds, temperature, and turbulence to improve aviation advisories and forecasts used by the National Weather Service.
- Human factors guidelines for shared information displays in air-to-ground communications.
- Selection criteria and training methods for operators and maintainers that reflect changes

in the operational environment and automation.

- Support to industry development of advanced avionics for small airplane and rotorcraft single pilot Instrument Flight Rules (IFR) to meet FAA requirements.
- Improved processes and practices in software development for the aviation industry and the FAA.
- Validation of Free Flight Operation Concepts.
- Prototypes of controller and Air Traffic Management decision support tools.
- Operational demonstrations of Automatic Dependent Surveillance – Broadcast (ADS-B) applications.

Program Area Structure

The ATS R&D program has been structured to support the following intended outcomes:

- Improve Quality and Availability of Weather Information
- Reduce Delays
- Improve System Flexibility
- Improve System Predictability

The ATS R&D program addresses these outcomes and strives to make the most efficient and effective possible use of R&D resources, with the objective of adding value to benefit NAS users, operators, and the public.

Customer and Stakeholder Involvement

The ATS R&D program extends to and supports the interests of a broad spectrum of the NAS user community. These involvements include those reflected in the Aviation Safety Plan, the RTCA Free Flight Action Plan, the NAS System Architecture, and the 2005 Concept of Operations documents for both ATS and the Commercial Space Transportation Program. Specific examples of customer and stakeholder involvement include:

- The R,E&D Advisory Committee (REDAC) provides guidance on the FAA's ATS investments. The REDAC Subcommittee for ATS reviews the ATS program and recommends ATS R&D investments. This program has seriously considered the Subcommittee's recommendations and has adopted much of their advice.
- The National Plan for Aviation Human Factors represents a cooperative effort between the FAA, NASA and DOD to establish a coherent national agenda for human factors research and development to improve the safety and efficiency of the NAS.
- The National Aviation Weather Users' Forum provides a process to develop a federal/industry consensus on the needs and priorities for aviation weather information and serves as a basis for seting priorities for research and development. Forum attendance includes representatives from:
  - The Airline Pilots Association (ALPA)
  - Airline Dispatchers Federation (ADF)
  - Air Transport Association of America (ATA)
  - Aircraft Owners and Pilots Association (AOPA)
  - Experimental Aircraft Association (EAA)
  - Helicopter Association International (HAI)
  - National Air Transportation Association (NATA)
  - National Association of State Aviation Officials (NASAO)
  - National Business Aircraft Association (NBAA)
  - Regional Airline Association (RAA)
  - American Airlines
  - Delta Airlines
  - Other facets of industry

Accomplishments

The following represents a partial listing of recent past accomplishments of the ATS R&D program:

- Developed prototype methodology to evaluate the impact of technological and Concept of Operations change on controller selection requirements.
- Completed Weather Support to Deicing Decision Making (WSDDM) technology transfer to commercial vendor for operational implementation.

- Implemented in-situ turbulence algorithm on multiple airframes.
- Completed convective weather forecast algorithm commercial technology transition.
- Completed national implementation of Next Generation Weather Radar (NEXRAD) Tornado Detection algorithm.
- Completed Standard Terminal Automation Replacement System (STARS) Early Deployment Capability Human Factors evaluation.
- Evaluated Enhanced Terminal Voice Systems (ETVS).
- Conducted Data Link Evaluation Simulations and Studies.
- Commenced design of a sensor for parallel runway wake turbulence sensing.
- Integrated terminal area weather products with automatic updates for airborne aircraft through use of Flight Information Service (FIS) broadcasts.

R&D Partnerships

The ATS R&D program continues to establish partnerships with U. S. Government agencies, international organizations, academic institutions, the airline industry, industry and industry user groups, and non-profit organizations. A listing of some of the current partnerships follows:

- U.S. Government Agencies
  - Department of Commerce
  - Department of Defense
  - National Aeronautics and Space Administration
  - National Science Foundation
  - National Weather Service
- International Organizations
  - British Civil Aviation Authority
  - EUROCONTROL
  - Direction Generale de L'Aviation Civile (DGAC)
  - International Civil Aviation Organization
- Academic Institutions
  - Embry Riddle Aeronautical University
  - Massachusetts Institute of Technology
  - Pennsylvania State University
  - San Jose State University
  - University of Maryland
  - University of Oklahoma
  - University of Quebec at Montreal
- Non-Profit Organizations
  - Advanced General Aviation Transport (AGATE) Consortium
  - RTCA
- Airline Industry
  - America West
  - American
  - Continental
  - Delta
  - Northwest
  - Southwest
  - Trans States
  - TWA
  - US Airways
  - United
- Industry and Industry User Groups
  - ALPA
  - ATA
  - Small Aircraft Manufacturers Association (SAMA)
  - AOPA
  - NBAA
  - Commercial Space Transportation Advisory Committee (COMSTAC)

Long-Range View

The essence of the ATS R&D program is to maintain a long-term view of the research requirements for the continued safe and efficient operation, maintenance, and use of the air transportation system today and to increase system safety, capacity and productivity.

Although the composition of the R&D program portfolio will change over time as some efforts transition to full-scale development or operational environments, continued investment in ATS R&D will ensure that the FAA stays current with the ever-increasing demands on the air traffic system.

The ATS R&D program is an ongoing effort with continuing funding expectations at or beyond the

current level. A continued investment in the ATS R&D will ensure the FAA has an effective risk identification/mitigation strategy for the high-risk areas of the future NAS architecture.

F&E 1F01 Runway Incursion Reduction

GOALS:

Intended Outcomes: With the Runway Incursion Reduction program (RIRP), the FAA intends to develop technologies and other solutions that minimize the chance of injury, death and damage, or loss of property due to runway accidents/ incidents within the civil aviation system. In addition, the program will improve safety and reduce the potential for accidents on the airport surface through increased pilot/controller situational awareness.

Agency Outputs:

- Develop low-cost airport surface detection equipment.
- Develop secondary surveillance capabilities for the airport surface.
- Develop a conflict-alerting and data fusion platform.

Investigate alternative options such as visual aids (lights and signs), education, training, and advisory circulars.

Customer/Stakeholder Involvement: The Air Traffic Requirements Office has been actively involved in developing requirements to meet objectives of reducing runway incursions. Additionally, the FAA Administrator has made runway incursion a priority within the Agency. Reducing runway incursions is second on the National Transportation Safety Board's (NTSB) "Most Wanted List" of safety improvements.

Accomplishments: The following R&D projects were accomplished in FY 2000:

- Completed initial multilateration/ADS-B, data fusion, and LOOP technology evaluation at Dallas, TX.
- Completed Phase II testing of LOOP technology system at Long Beach, CA.
- Completed informal evaluation of Airport Surface Detection Equipment Model X (ASDE-X) radars at Milwaukee, WI.

R&D Partnerships:

- Memorandum of Agreement (MOA) with NASA for Low-Visibility Landing and Surface Operations (LVLASO) demonstration in Dallas-Ft. Worth.
- Sensis (Vehicle Automatic Dependent Surveillance–Broadcast [ADS-B] and Aircraft Target Identification System [ATIDS]).
- CACI (safety algorithms).
- General working agreement with Volpe National Transportation Systems Center (VNTSC).
- Contract with Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation.
- Memorandum of Agreement with National Air Traffic Controllers Association (NATCA).

Runway incursion reduction technologies—including low-cost radar, secondary surveillance systems, conflict alerting systems, and other alternatives with various contractors—are currently being researched. After system evaluation is completed, specifications will be developed for soliciting competitive bids for production of successfully demonstrated systems. Periodic briefings will also be conducted during the Research, Engineering and Development (R,E&D) phase to inform industry of FAA's requirements for runway incursion reduction solutions.

The FAA recently awarded a contract to produce and install an ASDE-X system at 25 airports. The system will include a radar, multilateration system, and surveillance server.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Continue evaluation of data fusion technology and surface technology risk reduction activities at Dallas-Ft. Worth, TX.
- Conduct LOOP technology operational assessment (Phase III) at Long Beach, California.
- Develop final test requirements document and select test site for evaluation of runway status lights.
- Initiate Broad Agency Announcement (BAA), awarding 10 to 15 contracts to ven-

dors, allowing them to demonstrate new and emerging surface technologies.

- Develop surface technology roadmap.
- Initiate demonstrations resulting from BAA and draft reports relating feasibility of applications to the surface technology roadmap.
- Continue testing other technology prototypes including low-cost radar, conflict alerting systems, and other potential runway incursion reduction alternatives.
- Begin Runway Safety Blue Print Initiatives.
- Evaluate airport surface marking and painting technologies.
- Evaluate Advanced Taxiway Guidance System (ATGS) and Radio Frequency Identification (RFID) system.
- Improve operational procedures and educational awareness.
- Identify solutions to improve runway safety on airport surfaces.
- Conduct data collection and analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

- BAA technology demonstrations.
- Runway status lights technology demonstration.
- Runway Safety Blue Print initiatives, including controller training, simulator/markings, education and awareness program, technology continuations, human factors studies, and industry conferences.

FY 2002 PROGRAM REQUEST:

In FY 2002, funding will provide for:

- Continuing BAA demonstration and evaluation efforts in preparation for sponsor decisions.
- Conduct of a runway status lights technology demonstration and related analysis of results and findings.
- Information sharing with air traffic controllers, pilots, and vehicle operators.
- Continuation of ATGS/RFID system demonstration and evaluation activities.
- Simulation tools for training, modeling and measuring improvements/impacts of technology on runway safety.
- Conduct of education, training, and awareness programs.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$5,168
FY 2001 Enacted	11,500
FY 2002 Request	6,533
Out-Year Planning Levels (FY 2003-2006)	23,400
Total	$46,601

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Runway Incursion Reduction	0	* 2,269	2,000	11,500	6,533
Personnel Costs	0	899	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**3,168**	**2,000**	**11,500**	**6,533**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	3,168	2,000	11,500	6,533
Total	**0**	**3,168**	**2,000**	**11,500**	**6,533**

*** In FY 1999 $900K of contract funds were allocated to Free Flight Phase 1 Atlanta GA**

Runway Incursion Reduction Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
021-250 Runway Incursion Reduction							
Runway Incursion Plan	$3,700						
Phased Array Radar (Milwaukee)		◆	◇	◇	◇		
Data Fusion/ATIDS/ADS-B/Loops (DFW)		◆	◇	◇	◇	◇	◇
Loop Technology (Long Beach)		◆	◇				
FAA/NASA Evaluation (DFW)		◆					
Systems Selection for Full-Scale Validation Testing		◆	◇				
Continuous Research on Additional Technologies		◆	◇	◇	◇	◇	◇
Multi Lateration-Demo	$833		◇	◇			
Runway Incursion Non-Technical Solutions	$2,000						
Develop Procedures		◆	◇	◇	◇	◇	◇
Develop Educational Process		◆	◇	◇	◇	◇	◇
Develop Training Guidelines		◆	◇	◇	◇	◇	◇
Total Budget Authority	**$6,533**	**$11,500**	**$6,533**	**$5,700**	**$5,700**	**$5,700**	**$6,300**

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 System Capacity, Planning and Improvements

GOALS:

Intended Outcomes: System Capacity Improvement (SCI) research directly supports three of the FAA's strategic goals: 1) Safety - reducing fatal accident rates in support of Safer Skies goal; 2) Efficiency - reducing system delays, operational criteria development time, and significantly reducing implementation risks for NAS Architecture 4.0; and 3) Global Leadership - providing global leadership in capacity and aviation simulation research.

The FAA intends to develop an overall strategy to enhance capacity. This includes both terminal and en route airport and airspace assessment of procedures and capacity-related technologies, and problem solving methodologies addressing such issues as the identification and development of solutions to the planned introduction of New Large Aircraft (NLA) and Smart Aircraft Transportation System (SATS) in the National Airspace System (NAS). It also includes developing an ATS performance measurement system to measure FAA progress against customer expectations and relate that performance to relevant costs. This strategy coordinates across budgetary lines allowing programs and projects to improve investment decision making and to achieve optimal strategic and operational results.

Initiatives are implemented in aviation system capacity planning to increase the number of aircraft operations per hour, reduce both en route and terminal airspace delays, reduce controller workload, and increase savings. As a result, the FAA, and the overall aviation community, will experience lower maintenance/operating costs. This program: (1) complies with the congressional mandate to produce airport improvement plans; (2) responds to the aviation industry's high-priority initiatives for increased capacity; (3) responds to the Presidential Commission on Improved Airline Competitiveness recommendations; and (4) complies with the Government Performance and Results Act (GPRA) of 1993 and Executive Order on infrastructure investment requirements.

Agency Outputs: This program will, for the first time, integrate the performing elements of the FAA necessary to gain near term safety and capacity benefits. SCI provides an ongoing problem solving research capability. This need for a highly adaptive, rapid response capability is expected to exist until NAS Modernization is complete.

SCI establishes a dedicated set of resources, set aside specifically to respond to identified problems, agreed by the performing, regulatory and consuming interests to share some or all of the following characteristics:

- Maintains or enhances aviation safety.
- Offers the potential for immediate or near-term solutions.
- Offers significant relief at locations of transportational significance.
- Employs creative applications of existing or near-term technology.
- Requires "corporate" solutions.
- Either will not interfere with or may be superceded by national solutions when they become available.

To comply with GPRA, ATS has developed four areas of capacity-related outcomes: flexibility, predictability, access, and delay. These outcomes provide guidance and a framework to enable any ATS investment program to successfully increase the value of services and, in parallel, reduce the cost of these services to the public. The capacity program strictly adheres to the guidelines of the following four areas:

Flexibility:

The FAA estimates that each year operators experience a minimum of $558 million in inefficiencies in the terminal and en route airspace. The capacity program provides models and simulations that assess present shortfalls within the subject airspace. These models and simulations determine the delay, travel time, sector loading, and operating cost effects of all suggested redesign alternatives. Results include:

- The redesign of Las Vegas terminal and en route arrival procedures.

- New departure routes from Los Angeles International Airport.
- Airspace suggested changes to Phoenix departure procedures.
- New dual arrival procedures into San Francisco.
- Annual savings to the aviation industry at airports and en route facilities estimated at a minimum of $450 million annually.

Predictability:

Because it can impose capacity restrictions at major airports, weather is the most dominant influence on air transportation. Although many airports are equipped with multiple runways (many converging), their resources become extremely restricted due to associated weather minima. The capacity program establishes criteria to develop and improve simultaneous converging instrument approaches and has achieved the following results:

- Reductions in the approach minima, ensuring an average capacity gain of 30 arrivals per hour.
- Fundamental increases in the predictability of the system.
- Use (anticipated) of the Global Positioning System (GPS).
- Combined savings (estimated) to the air carriers of $40 million annually.

Access:

In the capacity program, the outcomes of predictability (the ability to land at a particular airport) and having access to that airport, are often considered the same thing. Work required to accomplish these outcomes, however, is different. Predictability establishes approaches to increase capacity under certain weather conditions. Access models simulate new technologies and procedures to ensure that these technologies are compatible for the airport in question. Examples include:

- Precision Runway Monitor—for closely spaced parallel runways with center lines separated by 3,000 feet (reduced from 4,300 feet).
- Reduced separation of 2.5 nmi on final approach (reduced from 3.0 nmi).
- Dependent staggered approaches to closely spaced parallel runways using 1.5 nmi diagonal separation.
- Offset Approach Course guidance for simultaneous operations at San Francisco, Newark, St. Louis, Cleveland, Seattle and other candidate airports.
- Converging approach standards at Chicago O'Hare, Dulles, and Dallas-Ft. Worth International Airports.

Delay:

The major capacity program emphasis is to minimize the impact of airport and airspace delay on the overall NAS. One primary program focus is responding to near-term, airport-driven capacity issues. By 2008, 21 of the top 29 large hub airports are projected to exceed an average of five minutes of delay per operation. This is cause for concern within the aviation industry. Delay reduction initiatives undertaken to date include:

- The capacity program has completed more than 50 airport enhancement projects.
- The program supports development of an overall capacity strategy that considers airport and technology conduct, measurement, and assessment; and electronic tools development and application to aid in forming that strategy.
- Airfield improvements such as new runways and runway extensions, improved approach procedures, and new facilities and equipment such as the Precision Runway Monitor are being investigated.
- The improvements producing the greatest capacity increases, estimated delay reductions, and delay cost savings, are described and recommended for implementation in the final design plans.
- The top recommendations at any one airport are estimated to save the aviation industry $75–$100 million annually.
- Since 1995, based on recommendations, 20 new runways have been constructed at major airports.
- Efforts are underway to accommodate New Large Aircraft into the operational environment.

The FAA's airport and airspace design programs have the dual objectives of addressing tactical improvements, in response to industry requirement shifts, and facilitating large-scale investment analysis and optimization planning. Securing active cooperation at the local (regional) level, and the high degree of coordination needed among affected facilities and user groups, pose process problems.

Various solutions to these problems have been proposed and simulated. The results have then been compared to make intelligent investment decisions. A detailed example follows:

Problem: On the Dallas-Ft. Worth Metroplex project, which involved substantial Airports Improvement Program (AIP), F&E, and operational investment, the effects on the system of several airspace structures, including a "do nothing" scenario, were compared.

Solution: Given the industry's plan to expand operations at Dallas-Ft. Worth, the FAA concluded it was best to expand the airport. This meant designing new airspace supported by upgraded navigation and communications capabilities along with entirely new arrival and departure procedures.

Result: This approach enabled the community to construct a new runway and ground infrastructure. It also enabled the industry to schedule growth and capital investment.

Comment: This plan instilled confidence that there would be a return on investment since the revised system could support anticipated demand. The industry and local community, therefore, could commit this expanded service to the public. The cumulative 20-year (1997–2016) estimated aircraft operating cost savings based on the Dallas-Ft. Worth Metroplex, East Runway, and New West Runway in 2003 is $13 Billion.

Customer/Stakeholder Involvement: Although the FAA directs the entire capacity program, customers and stakeholders play active roles in its success. Airport authorities from all concerned airports, air carrier representatives, aviation interest groups, and FAA regional and local air traffic control personnel are an integral part of every airspace and airport capacity task force/ project.

The System Capacity Improvement Program will be established within the Office of System Capacity and will be responsible for the establishment of a government/industry communication mechanism that will ensure an effective dialogue on the subject of NAS infrastructure improvement. This outreach system may be in the form of a formal advisory committee, a series of informal seminars, or individual meetings with relevant industry elements. Specific responsibilities of the System Capacity Improvement program office are:

- Serves as a single focal point for industry driven capacity enhancement projects (one stop shopping).
- Generates, coordinates and maintains work plans for capacity enhancement projects at least two years into the future.
- Reports on resource requirements, allocations and shortfalls to both FAA management and its industry outreach mechanism.
- Reports project status to both FAA's senior management and industry representatives.

The capacity program annually publishes the Aviation Capacity Enhancement Plan to keep the aviation world informed of progress and advancements in the capacity arena. Members of the international aviation community regularly request this document. Requestors in this country include Congress; scholars and students, who use it for their aviation studies; and aviation groups, who use it to develop congressional budget justifications.

As previously stated in "Goals," the overall capacity program parallels the congressional mandates concerning airport improvement plans and agency performance and results.

Accomplishments: Airport and airspace recommendations and redesign studies have produced a conservatively estimated $1.2 billion in savings to the aviation industry. An accurate estimate is difficult because the improvements, either combined or treated individually, are a direct cause of the constant increase in traffic. The program has recently accomplished the following:

- Prototyped and tested initial system performance measures.

- Completed more than 50 major airport studies—some of which have been updated due to growth. Estimated annual savings $75–$100 million per airport.
- Completed four major terminal/en route airspace redesigns: (1) Las Vegas approach procedures; (2) Los Angeles terminal procedure and ZLA Sectors; (3) Phoenix departure procedures; and (4) Dual arrival procedures into San Francisco.
- Completed aircraft ground movement analysis studies at Las Vegas and Salt Lake City International Airports.
- Completed Pales Verdes airspace environmental initiative.
- The program's achievements reach beyond U.S. airspace. Inquiries about our modeling and design methods and requests for assistance have been received from countries in Asia and Europe (e.g., Frankfurt am Main International Airport, Germany, and the new Kimpo International Airport in Seoul, South Korea).

R&D Partnerships:

- In accordance with the annex of the memorandum of understanding between the FAA and EUROCONTROL, the capacity program has established a joint airspace technologies and initiatives group to modernize international aviation. The intended outcome is to meet compatibility requirements between the United States and the rest of the aviation world in such areas as Free Flight, GPS, the Flight Management System, the Precision Runway Monitor, and other emerging technologies.
- The FAA will partner with major air carriers and business aviation aircraft in developing financial management systems approaches.
- The FAA will partner with NASA to further develop and demonstrate the Small Aircraft Transportation System (SATS), and continuance of wake turbulance efforts.
- The FAA will partner with NASA in using performance measures developed by the capacity program for ATS in compliance with the Congressional mandate for GPRA. The FAA will participate in joint computer simulation modeling for TRACON systems including the Center Tracon Automation System (CTAS) and the Standard Terminal Automation Replacement System (STARS).
- NASA Short Haul Civil Tiltrotor simulation of proposed Simultaneous Non-Interfering (SNI) Approach procedure.
- The FAA will partner with aircraft manufacturers Boeing and Airbus, avionics manufacturers, Municipal Airport Authorities, Airports Council International – North America, Air Transport Association, and the Airlines Pilots Association for proposed New Large Aircraft (NLA).
- Wide Area Augmentation System/Local Area Augmentation System (WAAS/LAAS) for Minimum Vectoring Altitude (MVA) and Automatic Dependent Surveillance – Broadcast (ADS-B) for closely spaced parallel runway analysis for Airports Council International – North America (ACI-NA).

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Conducted Continuous research to develop, refine, and/or enhance high-level outcome performance metrics that were then integrated into processes supporting GPRA requirements and investment decision making.
- Initiated Offset Approach Course guidance for simultaneous operations at San Francisco.
- Developed new Instrument Flight Rules (IFR) approach and departure concepts for improving the safety and efficiency of operations at capacity constrained airports.
- Identified the impact and developed proposed solutions to the planned introduction of New Large Aircraft in the NAS.
- Initiated converging approach standards at Chicago O'Hare International Airport.
- Initiated Airport Design Studies at John F. Kennedy, La Guardia, and Portland airports.
- Completed ground analysis at Phoenix Sky Harbor International Airport.
- Initiated efforts to accommodate New Large Aircraft into the operational environment.
- Completed Newark and Tampa Airport Design Studies.

- Participated in airport design study at Dulles International Airport and Baltimore-Washington International Airport.
- Developed procedural alternatives for increased capacity in Anchorage area.
- Completed experiment on civil tilt rotor operations into Newark.
- Explored 250 knot departure route restriction at Houston.
- Initiated and completed the Aviation Capacity Enhancement (ACE) Plan.
- Initiated NAS integration studies at 11 major airports.
- Completed airport capacity improvement demonstrations at Houston and Memphis airports.
- Conducted demonstration of Aviation System Capacity Improvement (ASCI) program at Houston and Memphis airports.
- Completed Anchorage Airport Design study.
- Completed Phoenix Airport Ground movement analysis.
- Initiate Seattle Airport Ground movement analysis.
- Completed NAS integration study of regional jets at LaGuardia and Dallas Ft. Worth.
- Completed NAS integration studies at six major airports.
- Completed capacity analysis for Runway 14/32 at Boston International Airport.
- Initiate Airport Design studies at Portland, Pittsburgh, and Boston.
- Continued solution development for introduction of New Large Aircraft (NLA) into the NAS.
- Completed analysis of the obstacle free zone – flight deck model for accommodation of NLA into the National Airspace System (NAS).
- Conducted wake turbulence separation standards reduction research at San Francisco and Boston.
- Participated in the development of Simultaneous Offset Instrument Approach (SOIA) procedures at San Francisco, Newark and St. Louis.
- Facilitated the development of Along Track Separation (ATS) procedures for operations at St. Louis and Minneapolis St. Paul.
- Supported development of domestic and international Required Navigation Performance (RNP) operational standards and procedures.
- Supported the development of enhanced departure and arrival procedures at Chicago O'Hare and Midway airports.
- Supported the development of triple approach procedures to new runways at Atlanta and Detroit.
- Completed the installation of NAS performance measurement analysis equipment at ATC System Command Center and Air Traffic Western Pacific Region and begin analysis.
- Expanded facility level metrics analysis capability to Air Traffic Southwest Region.
- Identified facilities level metrics program requirements for Airway Facilities.
- Developed En Route Balance Scorecard and conduct cost performance benchmarking and causal analysis.
- Completed 2000 Aviation Capacity Enhancement (ACE) plan.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Continue to develop new IFR approach and departure concepts and support ATP efforts for proceduresdevelopment.
- Transition offset approach course for simultaneous operationsn technologies at St. Louis and Newark.
- Continue to develop proposed solutions to integrate New Large Aircraft into the NAS.
- Complete airport design study at JFK, terminal area airspace study at Anchorage, and ground analysis at Phoenix Sky Harbor International Airport.
- Continue analysis of new and/or additional performance measures for the national airspace system.

- Conduct demonstration of the ASCI program at Atlanta, Philadelphia, Cleveland and Detroit airports.
- Support the development of parallel runway wake turbulence separation standards.
- Support fast and real time simulation of SOIA for site specific airports.
- Complete SOIA procedure development at San Francisco airport.
- Continue development of SOIA procedures at Newark, St. Louis, and initiate programs to support the development of procedures for operations at Cleveland and Boston airports.
- Finalize the Along Track Separation (ATS) recommendations for implementation at St. Louis, Minneapolis St. Paul and initiate programs to support the development of procedures for operations at Newark, Atlanta and Los Angeles airports.
- Support Multi-Lateration Procedures Development (MLPD) for operations at Memphis.
- Support the completion of converging approach standards (CASTWG) and departure procedures at Dallas-Fort Worth and Dulles Airports.
- Support efforts to analyze wake turbulence spacing at Seattle Airport.
- Complete the installation and development of NAS performance measurement analysis capability for Air Traffic's Western Pacific and Southwest Regions.
- Initiate NAS performance measurement analysis capability at Air Traffic Northwest Mountain and Central Regions.
- Initiate Airway Facilities NAS Performance measurement analysis capability and metrics development.
- Develop ATS Balance Scorecard for Flight Service and Terminal SDPs.
- Continue ATS Cost and Performance benchmarking and causal analysis.
- Continue analysis of new and/or additional performance measures for ATS.
- Initiate and complete a NAS integration study of new NAS technology.
- Complete Airport Design Studies at Portland, Pittsburgh and Boston airports.
- Initiate Airport Design Studies at Cincinnati, Memphis, and Los Angeles airports.
- Complete Aircraft Ground Movement Analysis at Seattle Airport.
- Initiate Charlotte New Runway Ground Movement Analysis and multi-lateration experiments.
- Complete 2001 Aviation Capacity Enhancement (ACE) Plan.
- Initiate capacity impact analysis of equipment location priorities in the NAS architecture.
- Initiate capacity impact analysis of selected NAS architecture capabilities.
- Initiate and complete study of Airport design for accommodation of New Large Aircraft (NLA) into the NAS by FY2006.
- Identify the impact and develop solutions to NASA's Small Aircraft Transportation System (SATS) Demonstration Program planned for FY2003 implementation.
- Identify constraints on the SATS proposal caused by existing ATC procedures and support the development of solutions.
- Support simulations (testing) of SATS procedures for safety and system efficiency impacts.
- Coordinate procedures for SATS with relevant facilities.
- Validate performance of NASA's SATS airframe/avionics package with testing to ensure adequate back-up procedure capabilities.
- Monitor efforts at enhancing ceiling and visibility forecasting for LAX.
- Participate in and support concept validation and application of ATC/ATM decision support tools to enhance arrival and departure management.
- Integrate ATC/AF Human Factors into capacity enhancements
- Initiate capacity analysis and safety assessment of domestic RVSM.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program will continue to focus on capacity enhancement at all major airports as well as on terminal and en route airspace. Primary focus areas are: (1) airports where construction of

suggested improvements can be completed within two to three years; and (2) air traffic radar facilities where airspace redesign reduces controller workload and provides the aviation industry with additional flexibility and predictability during flight.

In addition, the program will continue to fine tune air traffic system performance measures. These efforts will concentrate on reducing the cost of service delivery by targeting and coordinating investments across appropriations.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$3,055
FY 2001 Enacted	5,300
FY 2002 Request	5,300
Out-Year Planning Levels (FY 2003-2006)	26,300
Total	$39,955

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
System Capacity, Planning and Improvements	0	228	1,200	5,300	5,300
Personnel Costs	0	1,627	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**1,855**	**1,200**	**5,300**	**5,300**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	1,855	1,200	5,300	5,300
Total	**0**	**1,855**	**1,200**	**5,300**	**5,300**

Note: FY 1999 funding for this budget line item included the allocation for Separation Standards.

System Capacity, Planning and Improvements	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Capacity Improvement Initiatives	$1,500						
Demonstration Projects							
Houston/Memphis		◆	◇				
Atlanta, Philadelphia, Cleveland, Detroit			◇				
Architecture Deployment Support	$900						
Conduct Analysis of System Impact of Potential New Separation Criteria							
Along Track Separation (ATS) St. Louis Lambert, Minneapolis-St. Paul, Newark, Los Angeles, Atlanta		◆	◇	◇			
Simultaneous Offset Instrument Approach (SOIA)							
San Francisco, St. Louis Lambert, Newark, Boston, Cleveland		◆	◇	◇			
Develop Required Navigational Performance (RNP) Operational Standards and Procedures for Air Carrier Aircraft		◆	◇				
NAS Performance Measurement	$1,500						
Installed NAS Performance Measurement Equipment at ATCSCC and Air Traffic AWP region		◆					
Air Traffic and Airways Facilities metrics Development and Analysis		◆	◇				
Develop ATS Balance Scorecard for SDP's		◆	◇				
Conduct ATS Cost & Performance Benchmarking and Causal Analysis		◆	◇				
Expand facility level metrics equipment analysis to AAT Regions			◇	◇			
Regional NAS Performance Measurement Implementation				◇	◇	◇	◇
Airport Development	$600						
NAS Integration – Regional Jets/Additional New Runways/Major Airports		◆					
Boston Procedures Tactical Analysis for Runway 1432		◆					
Ground Movement Analysis at Phoenix, Seattle, Charlotte, Portland		◆					
Airport Design Study at Anchorage, Portland, Pittsburgh, Boston		◆	◇				
NAS Integration – New NAS Technology		◆	◇				
Kansas City Parallel Runways Tactical Analysis				◇			
Airport Analysis and Development Studies				◇	◇	◇	◇
NAS Architecture/ACE Plan Integration	$800						
Aviation Capacity Enhancement (ACE) Plan Development		◆	◇	◇	◇	◇	◇
Equipment Location Priority Analysis			◇	◇	◇	◇	◇
Capacity Impact Analysis of NAS Architecture Capabilities			◇	◇	◇	◇	◇
Total Budget Authority	**$5,300**	**$5,300**	**$5,300**	**$5,600**	**$5,900**	**$7,100**	**$7,700**

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 General Aviation and Vertical Flight Technology Program

GOALS:

Intended Outcomes: The General Aviation and Vertical Flight (GA & VF) Technology Program supports GA demands for Communications, Navigation And Surveillance (CNS) technologies through applied research and development. These technologies support cost-effective air traffic services, improve safety, and expand NAS capacity and efficiency – especially where CNS services are not currently available to GA users. GA & VF program products are integral to NAS modernization.

The GA & VF Technology Program supports research and development across the full spectrum of GA operations. The program's research areas align with the most critical components for GA participation in the NAS-terminal operations: enroute communications and navigation, landing facilities, airmen and controller training, and low-cost avionics.

Vertical flight Terminal Instrument Procedures (TERPS) efforts support the terminal and enroute flight environment. Low-altitude CNS research provides critical data and evaluations for future low-altitude enroute infrastructure to support Free Flight. TERPS capabilities facilitate implementation and use of advanced technology in the cockpit and controllers' workstations for GA needs. These efforts are interrelated and support mutual requirements without duplication or added costs.

Agency Outputs: The GA & VF Technology Program helps generate design criteria, publish Advisory Circulars (AC) and training documents, and provide for collaborative technology integration with the current and future NAS. This program area also provides technical and management expertise to establish highly successful partnerships.

The project creates the following types of products and engages in the following activities related to rotorcraft Instrument Flight Rules (IFR) procedures and infrastructure:

Terminal Airspace

Criteria and design parameters for instrument approaches to hospital, corporate, and business district heliports. This development effort supports TERPS criteria, aircraft and avionics certification standards, IFR, Emergency Medical Service (EMS) procedures and training guidance, as well as Minimum Aviation System Performance Standards (MASPS), Minimum Operational Performance Standards (MOPS), and Technical Standard Orders (TSO).

Rotorcraft Air Routes

Procedures and test systems designed in an operational environment to work with Global Positioning System (GPS) navigation, surveillance and terrain avoidance technology developed by other projects. Resulting experience and information helps to integrated newer, safer, and more efficient rotorcraft routings into the NAS including the Gulf of Mexico, and can be useful to other GA systems operating at low altitudes.

Avionics and Cockpit Technology

Avionics, equipment, procedures, and related testing to enable the safe, efficient integration of GA aircraft into the NAS. These efforts have become particularly important with the introduction of GPS navigation/landing and surveillance systems, Free Flight, and other advanced concepts.

Low Altitude CNS Infrastructure

Route system guidelines, cockpit display guidelines, noise abatement procedures, and terminal and enroute system integration plans for low altitude CNS operations.

Customer/Stakeholder Involvement: The GA program directly supports goals and programs delineated in Challenge 2000, the Aviation Safety Plan, the RTCA Free Flight Action Plan, and NAS architecture development. The program emphasizes the VF community's direct needs related to helicopters and tiltrotors. Stakeholders include:

- Helicopter Association International (HAI)
- American Helicopter Society (AHS)
- National Business Aircraft Association (NBAA)

- Experimental Aircraft Association (EAA)
- Aircraft Owners and Pilots Association (AOPA)
- General Aviation Manufacturers Association (GAMA)
- Small Aircraft Manufactures Association (SAMA)
- National Association of State Aviation Officials (NASAO)
- Association of Aeronautical Medical Services
- National Emergency Medical Services Pilots Association
- Airborne Law Enforcement Association

Accomplishments:

- Completed evaluation of current technology to support precision IFR approaches to heliports and vertiports.
- Developed Vertical Flight Satellite Navigation (SATNAV) Road Map.
- Developed an operations concept plan to provide enhanced weather data and Flight Information Services to helicopter operations in the Gulf of Mexico as part of the next generation CNS technology.
- Developed a strategic plan and operations concept for vertical flight operations using advanced technology.

R&D Partnerships: Historically, the GA & VF Technology Program has maintained a unique R&D collaboration with industry. Partnerships, existing or planned for the near future, include:

- Experimental Aircraft Association in advanced technology avionics – for single pilot GA aircraft.
- Helicopter manufacturers and user organizations – to focus development of IFR procedures (including approaches) as well as systems and equipment to meet user identified and validated operational needs.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Developed criteria for the publication of mountain pass waypoints on Vertical Flight Rules charts.
- Supported the development of procedures and standards to enable Simultaneous Non-Interfering (SNI) operations between fixed-wing and vertical flight aircraft.
- Conducted flight tests and data analysis to investigate the potential improvement in efficiency for time-critical VF operations, such as law enforcement and emergency medical service.
- Evaluated helicopter performance through flight tests and data analysis to define aircraft and avionics requirements for steep angle approaches (greater than three degrees) to a heliport/vertiport.
- Identify lighting requirements to support helicopter Instrument Landing System (ILS) instrument approaches to 100-foot height-above-touchdown decision altitudes.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Enhance fixed wing/rotorcraft vertical flight rule procedure technology application standard by continuing research that supports use of advanced avionics (including GPS navigation, dependent surveillance, and cockpit display of traffic and weather information).
- Establish lighting requirements for heliports and vertiports to support instrument landing system and capabilities for vertical flight aircraft.
- Initiate efforts to use non-radar surveillance system in the Gulf of Mexico for FAR 135.79 Flight Locating Requirements.
- Initiate research to support steep angle IFR approaches and missed approach guidance for helicopters and tiltrotors.
- Continue research leading to establishing improved low speed GPS precision approach TERPS criteria for vertical flight aircraft operations.
- Improve the distribution of weather information in the Gulf of Mexico to pilots operating helicopters at low altitudes.
- Develop procedures and standards for vertical flight simultaneous non-interfering VFR and IFR operations in terminal areas.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues to focus on the areas listed at the beginning of the GOALS section above. Specific areas are simultaneous non-interfering operations in the terminal area and precision approaches to heliports and vertiports.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$3,402
FY 2001 Enacted	900
FY 2002 Request	1,000
Out-Year Planning Levels (FY 2003-2006)	5,600
Total	$10,902

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
General Aviation and Vertical Flight Technology Prog	0	1,462	500	900	1,000
Personnel Costs	0	1,440	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**2,902**	**500**	**900**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	2,902	500	900	1,000
Total	**0**	**2,902**	**500**	**900**	**1,000**

General Aviation and Vertical Flight Technology Program Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
General Aviation	$200						
Developed Criteria for the Publication of Mountain Pass Waypoints on VFR Charts		◆					
Enhance Fixed Wing/Rotorcraft VFR Procedures Technology Applications Standards by Continuing Research Supporting Use of Advanced Avionics			◇	◇	◇	◇	◇
Vertical Flight	$800						
Evaluate Helicopter Performance Through Flight Tests and Data Analysis to Define Aircraft and Avionics Requirements for Steep Angle Approacher (Greater Than 3 Degrees) to a Heliport/Vertiport		◆	◇	◇	◇	◇	◇
Conducte Flight Test and Data Analysis to Investigate the Potential Improvement in Efficiency for Time-Critical Vertical Flight (VF) Operations, Such as Law Enforcement and Emergency Medical Service		◆	◇				
Develope Procedures and Standards to Enable Simultaneous Non-Interfering (SNI) Operations Between Fixed-Wing and Vertical Flight Aircraft		◆	◇	◇	◇	◇	◇
Identified Lighting Requirements to Support Helicopter Instrument Landing System (ILS) Instrument Approaches to 100' Height Above Touchdown Decision Altitudes		◆					
Initiate Efforts to Use Non-Radar Surveillance in the Gulf of Mexico for FAR 135.79 flight Locating Requirements			◇	◇			
Initiate Research to Support Steep Angle IFR Approaches and Missed Approach Guidance for Helicopters and Tiltrotors			◇	◇	◇	◇	◇
Improve the Distribution of Weather Information in the Gulf of Mexico to Pilots Operating Helicopters at Low Altitudes			◇	◇	◇		
Total Budget Authority	$1,000	$900	$1,000	$1,200	$1,400	$1,500	$1,500

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

Safe Flight 21

GOALS:

Intended Outcomes: Safe Flight 21 is a government/industry initiative to demonstrate and validate, in an operational environment, the capabilities of advanced communications, navigation, surveillance, and air traffic procedures designed to improve flight safety and to increase capacity and efficiency. The program will be a step in implementing capabilities that prove to be beneficial. Specifically, Safe Flight 21:

- Addresses pilot and controller human factors issues.
- Develops and assesses new operational procedures and associated training.
- Streamlines certification processes and procedures.
- Develops a cost-effective avionics and NAS infrastructure.
- Defines a realistic NAS transition path supported by the user community.

Agency Outputs: Safe Flight 21 is essential to the risk mitigation and evolution of emerging technologies into the NAS. The program will address the risks and challenges of fielding advanced communications, navigation, and surveillance systems, such as Automatic Dependent Surveillance – Broadcast (ADS-B), Controlled Flight Into Terrain (CFIT) avoidance, Flight Information Services -- Broadcast (FIS-B), and the Traffic Information Service – Broadcast (TIS-B).

These objectives will be achieved through the following:

- Evaluating the three ADS-B links (1090MHz, Universal Access Transceiver (UAT), and VHF Datalink (VDL) Mode 4).
- Conducting operational evaluations of the following nine operational enhancements identified by RTCA:
  - FIS-B for Special Use Airspace (SUA) status, weather, wind-shear, Notices To Airmen (NOTAMs), and Pilot Reports (PIREPs).
  - Cost-effective Controlled Flight Into Terrain (CFIT) avoidance through graphical position display.
  - Improved terminal operations in low-visibility conditions.
  - Enhanced see-and-avoid.
  - Enhanced enroute air-to-air operations.
  - Improved surface surveillance and navigation for pilots.
  - Enhanced airport surface surveillance for controllers.
  - ADS-B surveillance in non-radar airspace.
  - Establishing ADS-B-based separation standards.

Customer/Stakeholder Involvement: The Safe Flight 21 program resulted from inputs that the FAA Administrator requested from the RTCA Select Committee on Free Flight Implementation. It is a jointly developed program strongly endorsed by the RTCA Free Flight Steering Committee. The Safe Flight 21 Steering Committee is the focus for ongoing coordination between stakeholders and the Safe Flight 21 program, and includes RTCA Select Committee representatives from the FAA, the Aircraft Owners and Pilots Association (AOPA), the Airline Pilots Association (ALPA), the Air Traffic Control Association (ATCA), the Cargo Airline Association (CAA), the MITRE Corporation, U.S. Airways, and the Alaska Capstone Program Office.

Accomplishments in FY 2000:

- Published the operational evaluation (OpEval) final report from the first OpEval in Wilmington, Ohio, conducted in FY 1999.
- Established an OpEval Coordinating Group (OCG) to accomplish the detailed planning for a second evaluation (OpEval-2) in Louisville, Kentucky to be conducted 1st quarter, FY 2001.
- Established or modified operational concepts and procedures required to support the Safe Flight 21 applications to be evaluated in OpEval-2, specifically:
  - Approach spacing

  - Departure spacing
  - Runway and final approach occupancy awareness
  - Airport surface situational awareness
- Began preliminary analysis for NAS-wide implementation of ADS-B.
- Acquired and installed a "single stack" Common ARTS automation system at the Louisville Terminal Radar (TRACON) facility, to be evaluated by air traffic controllers for the airborne ADS-B applications.
- Developed and installed two Safe Flight 21 color displays at the Louisville TRACON for evaluation of ADS-B applications by controllers.
- Acquired and installed ADS-B avionics and displays with moving map capability in three WJHTC (FAA Technical Center) aircraft, to be used in OpEval-2.
- Coodinated avionics requirements with industry avionics manufacturers.
- Acquired and installed a multilateration/ ADS-B surface surveillance system at Memphis, Tennessee in preparation for an FY 2001 OpEval focusing on surface management.
- Conducted evaluation of ADS-B link characteristics based on established criteria.
- The following has been accomplished under the Safe Flight 21 Capstone Program in Alaska:
  - Seventy-four aircraft have been equipped with certified Capstone avionics.
  - Three operational remote ADS-B ground stations have been installed at Bethel, Cape Romanzof, and Cape Newenham, Alaska.
  - ADS-B surveillance capability has been established at Anchorage Center.
  - New, standalone GPS approaches have been published for six remote village airports.
  - Additional Automated Weather Observation Systems (AWOS) with weather cameras have been installed, with the first site operational at Mountain Village, Alaska.
  - Over 100 pilots and associated personnel have been trained on Capstone avionics though the University of Alaska.

R&D Partnerships: The Safe Flight 21 program is based on the principle that government and industry will share in the development and implementation of new communications, navigation, and surveillance technologies as the nation enters the Free Flight era.

The FAA will partner with the aviation industry in supporting Safe Flight 21. This will allow the FAA to build on ongoing industry initiatives. It will also allow industry and the FAA to fund avionics and ground systems. Safe Flight 21 will build on Alaska Capstone and Ohio River Valley activities by:

- Identifying and resolving ADS-B technology issues.
- Developing ADS-B operational concepts.
- Focusing data collection activities during OpEvals to answer as many operational and avionics certification issues as practical.
- Focusing on cockpit human factors issues.
- Exploring the use of TIS-B and FIS-B data link messages to receive traffic, weather, and other information in the cockpit.
- Developing, in conjunction with industry partners, an integrated cockpit display of terrain, traffic, and weather information.
- Ensuring that organizations representing controllers and commercial and general aviation pilots are included in Safe Flight 21 planning and in the evaluation of operational enhancements and data link alternatives.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

The FAA anticipates accomplishing the following activities in support of Safe Flight 21 in the Ohio River Valley and Alaska in FY 2001:

- Completed preliminary analysis for NAS-wide implementation of ADS-B, begun in FY 2000.
- Conducted OpEval-2 at Louisville, Kentucky, in 1st quarter FY 2001, to demonstrate applications and gather data on approach spacing, departure spacing, runway and final approach occupancy awareness, and airport surface situational awareness.

- Conducted detailed data analysis and publish OpEval-2 final report.
- Optimized Memphis multilateration/ADS-B system in preparation for OpEval-3 at Memphis.
- Conducted OpEval-3 phase I at Memphis in 3rd quarter FY 2001, focusing on system integration of multilateration system and real-time data collection using the Dynamic Runway Occupancy Measurement System.
- Continued air traffic procedure development for terminal and enroute environment.
- Developed TIS-B and FIS-B requirements and specifications.
- Began installation of a TIS-B and FIS-B broadcast capability at Memphis.
- Updated the Operational Safety Assessments (OSA) of SF-21 Enhancements that use ADS-B, which will include an assessment of each hazard identified in the existing OSA (each of which will be evaluated in the context of the Safe Flight 21 ADS-B applications).
- Conducted a Preliminary Hazard Assessment (PHA) of ADS-B technology, which will include updating and modifying the existing ADS-B Initial Hazard Analysis (IHA) to meet the requirements for a PHA in accordance with the NAS Modernization System Safety Program Plan (SSMP).
- Conducted a Comparative Safety Assessment (CSA) to compare the NAS with ADS-B and without ADS-B at a future state.
- Conducted a CSA of ADS-B as a Conflict Detection and Resolution technology.
- Completed technical assessment of candidate ADS-B links.
- Certified the Anchorage Micro-En Route Automated Radar Tracking System (EARTS) for radar-like services using ADS-B and begin service provision.
- Completed ADS-B avionics installation in remaining Capstone-participating aircraft.
- Demonstrated incorporation of WAAS technology with Capstone avionics in southeast Alaska.
- Evaluated FIS-B products and capabilities in the cockpit.
- Obtained globally harmonized ADS-B link decision.
- Approached the Joint Resource Council (JRC) for limited deployment of ADS-B applications in Alaska statewide.

KEY FY 2002 PRODUCTS AND MILESTONES:

Key FY 2002 products and milestones involve activities related to the limited implementation of ADS-B applications in the Ohio River Valley and Alaska that prove beneficial in meeting the intended outcomes of improving flight safety and increasing capacity and efficiency.

Avionics and ground systems

- Coordinate within FAA to initiate the integration of ADS-B into the ARTS and STARS baselines.
- Complete initiated procurement activities to acquire avionics for OpEval use with airport surface moving maps and TIS-B and FIS-B products.
- Complete installation of a TIS-B and FIS-B broadcast capability at Memphis.
- Conduct end-to-end evaluations.

Engineering and operational evaluation

- Conduct OpEval-3 Phase II in Memphis in 1st quarter FY 2002, focusing on a cooperative, interactive Surface Management System with decision support tools.
- Begin measuring system benefits at Memphis against an established baseline.
- Conduct OpEval-4 in Memphis in third quarter FY 2002, focusing on terminal airspace applications, TIS-B and FIS-B broadcast services in the terminal airspace, and a full-up demonstration of an integrated surface environment to enhance safety and efficiency.
- Start Investment Analysis for NAS-wide ADS-B implementation.

FY 2002 PROGRAM REQUEST:

FY 2002 funding completes procurement of avionics and ground systems necessary to conduct operational evaluations. The funding also provides for operational evaluation, procedures development, certification tasks, and simulation activities.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$32,000
FY 2001 Enacted	35,000
FY 2002 Request	24,000
Out-Year Planning Levels (FY 2003-2006)	109,400
Total	$200,400

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Safe Flight 21	0	16,000	16,000	35,000	24,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**16,000**	**16,000**	**35,000**	**24,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	16,000	16,000	35,000	24,000
Total	**0**	**16,000**	**16,000**	**35,000**	**24,000**

Safe Flight 21 (Capstone Initiative/Ohio Valley) Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Safe Flight 21 (Capstone Initiative/Ohio Valley)							
Operational Enhancements	$24,000						
Provide Weather and Other Information to the Cockpit		◆	◇	◇			
Provide Affordable Means to Reduce Controlled Flight Into Terrain (CFIT)		◆	◇	◇			
Improve Capability for Approaches in Low Visibility Conditions		◆	◇	◇			
Enhance Capability to See and Avoid Adjacent Traffic		◆	◇	◇			
Enhance Capability to Delegate Aircraft Separation Authority to the Pilot			◇	◇	◇	◇	◇
Improve Capability of Pilots to Navigate Airport Taxiways		◆	◇	◇	◇		
Enhance Capability for Controllers to Manage Aircraft and Vehicular Traffic on Airport Surface		◆		◇	◇	◇	◇
Provide Surveillance Coverage in Non-Radar Airspace		◆		◇	◇	◇	
Provide Improved Separation Standards		◆					
Data Link Evaluation		◆					
Program Management and Support		◆	◇	◇	◇	◇	◇
Safety Assessment		◆	◇	◇			
Total Budget Authority	$24,000	$35,000	$24,000	$26,400	$31,400	$29,100	$22,500

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.
– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.
– The FY 1999 Facilities and Equipment appropriation allocated $11M for the Alaska Capstone project and $5 for the Ohio Valley project.
– In FY 2000 Safe Flight 21 was Funded in F&E Budget Activity 1.

F&D 1F01 — Operations Concept Validation

GOALS:

Agency Outputs: The agency provides:

- A well-defined and well-understood "validated" operational concept based on system modeling and simulation.
- Validated, integrated, configuration managed requirements for the subsystems of the new target system to provide a coherent, comprehensive framework to guide associated research and development activities (e.g., specific requirements for Automatic Dependent Surveillance Broadcast (ADS-B) capabilities, Surface Management capabilities, Advanced Concept Probe).
- Top-level designs for the major new Air Traffic Management (ATM) capabilities and subsystems associated with the operational concept (e.g., the ground-based and airborne information infrastructures required for modernization and the design of a capability to dynamically tailor an air traffic controller's airspace responsibility to more efficiently accommodate traffic demand).
- A system-level safety assessment of the operational concept and associated new capabilities.
- A risk-mitigation plan to guide development activities for new capabilities.
- A human factors validation plan that provides a comprehensive roadmap of activities to ensure that new functionality will be operationally acceptable to flight crews and controllers.

Customer/Stakeholder Involvement: The RTCA Select Committee for Free Flight Implementation cooperates in operational concept development and validation. The FAA has conducted a detailed survey of the major stakeholders to obtain their ranking of future concept sub-elements to support modernization. This level of stakeholder participation, essential for validating the concept for a modern NAS based on a shared, integrated infrastructure, ensures that the concept fully reflects user community requirements.

Accomplishments: The vision for the modern NAS has been developed and published in the *Government/Industry Operational Concept for Free Flight* (RTCA, August 1997) and *A Concept of Operations for the NAS Airspace System in 2005* (Air Traffic Services, September 1997). These documents have provided guidance to the development of the NAS Architecture Version 4.0. Additional details appear in the appendices to this document.

Starting in FY 1999, activities initiated included validation of concepts and associated top-level designs, risk-mitigation planning, and coordination of a validation plan with the human factors activity. These activities include:

Operational concept development

- Developed a detailed framework for individual service enhancement and domains to support the development of system level requirements for modernization.
- Developed a NAS performance model for evaluating the impact of proposed concepts on operational performance. Developed quantitative measures and goals for midterm concept capabilities.
- Developed detailed concepts for individual service enhancement and domains to support the development of system level requirements for modernization (in particular, to support development of a concept of use for integrated Decision Support Tools for the 2003-2005 timeframe).

Concept validation

- Conducted a comparison of U.S. Eastern Triangle operations to European core airspace.
- Developed the capability for fast-time analysis of new concepts such as multi-sector planning and dynamic resectorization.
- Conducted joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations.

Concept system design

- Conducted an analysis of the effects of dynamic boundaries on operational and controller performance. This is a step in the development of dynamic sectorization to support

increased route flexibility in the face of increasing demand.

- Conducted analysis of en route sectorization strategies to support the mid-term design for the Eastern Triangle.

R&D Partnerships: This work directly relates to the FAA/NASA Memorandum of Understanding (MOU) on ATM research and development. Work under this program is coordinated through the joint Integrated Product Team Plan to ensure NASA's efforts complement and are integrated into the NAS Operational Concept. NASA contributes to the development and validation of flight deck concepts and in the far-term ATM system development.

The concept development and concept validation effort is also coordinated with the European community via agreements with EUROCONTROL. This effort ensures that unique solutions/transitions are not developed in different quadrants of the globe, which would impose an undue burden on U.S. carriers, manufacturers, and other participants in the global airspace system.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Operational concept development

- Developed detailed concepts for Flight Intent.
- Developed detailed concepts for Information Management of airspace resources to facilitate improved flight planning and impact assessment.

Concept validation

- Developed testbed for modernization.
- Performed airspace assessment of gridded airspace uniform ultra-high sectors, ultra-high centers.
- Developed information flow model to translate concepts into interface requirements.

Concept system design

- Conducted closed-loop modeling of changes in airspace/airports and user demand.

KEY FY 2002 PRODUCTS AND MILESTONES:

Operational concept development

- Develop detailed concepts of operations for the interaction of service providers in en route and terminal airspace to support the validation of the FAA's Airspace Management Concept.
- Develop detailed concept of operations for the evolution of Traffic Flow Management.
- Develop concept and potential measures for Required Total System Performance (RTSP).

Concept validation

- Establish the Validation Data Repository to capture all activities and results associated with concept and concept of use validation activities in the FAA. Establish metrics to allow comparability of results across program validation efforts in the U.S. and Europe.
- Conduct SWIM –System Wide Information Management (SWIM) concept validation.
- Validate the flight intent concept of use to assure completeness and harmonization of the definition for integration into ground and airborne decision support systems in the US and Europe.

Concept system design

- Extend closed-loop system dynamic modeling of decisions and demand dynamics related to scheduling and management of aircraft in congested en route airspace.
- Leverage the work in the human factors research and the human factors and the operational validations experimentation to define the information type, update rate, and display requirements that needed to support the agreed to operational improvements of the NAS concept of operations through 2010.

FY 2002 PROGRAM REQUEST:

The FY 2002 request extends the high level concept of operations and the early validation efforts into detailed concepts of operation for the evolution of Airspace Management and Traffic Flow Management. Concept validation efforts provide the performance requirements for information management to support the tactical and strategic common situational awareness assumption and needs of the next generation of ground and airborne support systems, including weather and traffic information distribution. The

operational concept validation efforts extend the identification of information type, update rate, and display requirements to decision support tools in general. The request also extends the development of performance measures to validate the operational improvements of future concepts as well as dynamic models of the interactions of schedule and control decisions on the performance of the NAS.

Also leveraging work is being performed by: (1) EUROCONTROL on the European Air Traffic Management System (EATMS) Concept and the associated ATM 2000+ strategy, and (2) the FAA in support of the International Civil Aviation Organization (ICAO) Air Traffic Management Concept Panel.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$9,018
FY 2001 Enacted	1,400
FY 2002 Request	2,500
Out-Year Planning Levels (FY 2003-2006)	15,900
Total	$28,818

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Operations Concept Validation	0	3,412	2,200	1,400	2,500
Personnel Costs	0	3,406	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**6,818**	**2,200**	**1,400**	**2,500**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	6,818	2,200	1,400	2,500
Total	**0**	**6,818**	**2,200**	**1,400**	**2,500**

Operations Concept Validation Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Operations Concept Validation							
Operational Concept Development	$300						
Develop Detailed Concepts for Flight Intent		◆	◇				
Develop Detailed Concepts for Information Management of Airspace Resources to Facilitate Improved Flight Planning and Impact Assessment		◆	◇	◇			◇
Concept Validation	$800						
Develop Testbed for Modernization		◆	◇	◇	◇	◇	◇
Perform Airspace Assessment of Gridded Airspace Uniform Ultra-High Sectors, Ultra-High Centers		◆	◇	◇	◇	◇	◇
Conduct Joint FAA/NASA/User Concept Validation Activities, Including Human-in-the-Loop Simulations		◆	◇	◇	◇	◇	◇
Complete Development of Information Flow Model to Translate Concepts into Interface Requirements		◆	◇	◇	◇	◇	◇
Validate flight intent concept			◇	◇	◇	◇	
Conduct Closed-Loop Modeling of Changes in Airspace/ Airports and User Demand		◆	◇	◇	◇	◇	◇
Ops Concept Development	$300						
Develop Detail Concepts of Operations for Interaction of Enroute & Terminal			◇	◇	◇	◇	
Develop Concept for Evolution of Traffic Flow Management			◇	◇	◇	◇	
Develop Concept & Measures for RTSP			◇	◇	◇	◇	◇
RTCA	$400						
Communication Concepts & Standards Ground/Ground	$700						
Total Budget Authority	$2,500	$1,400	$2,500	$2,600	$2,700	$5,000	$5,600

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 Software Engineering R&D

GOALS:

Intended Outcomes: The FAA intends to improve NAS and avionics safety and reduce NAS and avionics acquisition, development, and maintenance costs by developing and implementing improved software processes and procedures. These actions will directly benefit passengers (as well as all elements of air transportation) and greatly contribute to a safe, secure, and efficient NAS.

The FAA Software Engineering Resource Center (SERC), established in June 1998, is a focal point for research on FAA software-intensive systems. The SERC is an FAA-wide resource that addresses strategic software technology problems impacting the mission performance and enhancement of FAA in-house software/systems engineering competencies. The primary SERC facilities are located at the William J. Hughes Technical Center.

Agency Outputs: The principal products of SERC efforts include a series of standards, guidelines, models, research papers, and "evolvable" prototypes. They demonstrate, validate, and verify the safety properties, performance, and other critical attributes of anticipated new NAS technologies. The SERC also evaluates and validates improved software processes, methods, and engineering tools that enhance architecture and systems, as well as engineering, testing, and certification functions for the life cycle of NAS systems software. The SERC brings together recognized experts and FAA personnel to solve problems related to Commercial Off-The-Shelf/Nondevelopmental Item (COTS/NDI) and the next generation architecture. These activities transfer skills to and increase the technical competency of the FAA workforce.

Following are specific focus and outcomes of SERC applied research work:

Research on applying COTS/NDI within the NAS ground systems and avionics

- COTS/NDI software assurance research: This research directly supports the Flight Controls and Digital Avionics Systems by investigating conditions that allow COTS software products to be certified to a given currently-defined level of safety. It will help establish selection criteria and evaluation guidelines for ongoing work in Information Security Product Evaluation and a number of other related areas, such as NAS Infrastructure. The research also will identify and evaluate techniques for reducing cost and schedule to ensure that COTS/NDI software sytems are safe and function as required.
- Evaluation and prototyping of systems and software engineering processes and methods for use in COTS-intensive systems: This research will identify and evaluate more effective practices for use in software requirements definition, software analysis and design, and testing that are appropriate for safety-related systems using COTS/NDI software. It includes investigating methodologies to quantify, characterize, and guard against the risk of accidentally activating unintended COTS functionality for a given system and environment.
- Software estimation models for COTS-intensive systems Research is seeking to identify/develop better ways of estimating and predicting the life cycle costs of COTS-intensive systems: This study will include consideration of the complex interactions of major cost and schedule drivers that relate to the evaluation, interfacing, integration, product refreshment, and maintenance of COTS.

This research will produce a set of evaluation criteria and guidelines for COTS software proposed for use in safety-related aviation systems. It will also establish the processes and technical methods required to evaluate COTS/NDI-based systems prior to contract awards and ensure that use of COTS/NDI software will not compromise aviation system safety.

NAS architecture research

- Evaluation and prototyping of high-integrity, safety-critical architectures: The emphasis is to find better and less expensive ways to ensure that NAS hardware and software are safe, secure, and efficient in the face of chal-

lenges from bad code, security breaches, and the like.

- Architecture definition and description: This research is investigating unified approaches to formal architecture definition and description for cost-effective evaluation and comparison of competing candidate architectures for acquisition.
- Analytical and simulation architecture models for the NAS: This research is investigating the operational effects of optimized constraints, including cost and performance, before committing resources to NAS systems implementation and deployment.

Specific research outputs will be guidelines and standards for defining, representing, and designing high-integrity architectures for the NAS and, executable and reusable architecture models and simulations that can be extended or tailored to support NAS domain-specific engineering and product acquisitions.

Software certification research

- Processes for certifying software of safety-critical airborne and ground-based systems within the NAS. Current certification processes require a long lead time and are costly: Resulting delays affect the rate at which aircraft can be equipped with modern, affordable avionics and are a significant contributor to the long lead time required for NAS modernization. This research is exploring promising techniques for streamlining the certification process without affecting levels of safety.
- Processes for ensuring end-to-end safety and certification of integrated air and ground systems within the NAS: Air and ground segments are becoming more integrated within the NAS through new services such as data link. The current practice of separately certifying NAS airborne and ground components can no longer be relied upon as the sole means to ensure safety of the integrated air-ground system. This research is investigating and will validate different approaches for performing end-to-end safety assessments and certification of the integrated air-ground systems.

This research will produce a series of guidelines and processes for improving certification of avionics and ground systems. Specific recommendations will also be provided to the appropriate RTCA committees that develop standards and guidelines for certification of avionics systems.

Customer/Stakeholder Involvement:

The goal of streamlining the software aspects of certification is to assess cost and schedule drivers for certifying both avionics and ground systems software, and to prototype solutions that may reduce cost and schedules. This supports objectives of the Office of the Associate Administrator for Research and Acquisitions (ARA) and the Office of the Associate Administrator for Regulation and Certification (AVR).

Recommendation R-14 of the "Report of the Challenge 2000 Subcommittee of the FAA R,E&D Advisory Committee for the Administrator" reads, in part:

> The FAA should conduct an in-depth analysis of processes within the FAA which are affected by COTS/NDI technologies. . . . 5. Identify new methods to test and validate safety-critical systems that are not dependent on source code analysis. 6/7. Investigate ways to reduce cost and time to (re)establish high confidence in a system. . . 18. Promote software technology and process improvement techniques. . .

The SERC's COTS/NDI software assurance research work is directed toward answering the recommendations of this Subcommittee and also addresses concerns and recommendations contained in the *COTS/NDI in Safety-Critical System* report. This research also supports *Action Plan 5: Validation and Certification Methodology* of the FAA/EUROCONTROL R&D Committee agreements.

The *Subcommittee Report of the NAS ATM R&D Panel to R,E&D Advisory Committee* addresses the entire contents of its section 4.0 to Software Engineering Research and Development. It concludes with a number of critical recommendations concerning the need to initiate research in (1) certification of ground as well as air systems involving critical software; (2) systems/software

complexity; (3) various software architectural issues such as reuse and reliability; and (4) software/computer security. This is all captured within several sections, beginning with the Major Recommendation 4.2.1.a #2, "The FAA should establish a Software Engineering Laboratory under the direction of the Chief Scientist for Software Engineering that performs as a center of excellence." A major purpose of this research initiative is to address the concerns and identified weaknesses noted by the Subcommittee.

ACCOMPLISHMENTS:

Research on applying COTS/NDI within the NAS ground systems and avionics

- Completed first phase of development of a Constructive COTS Cost Estimation Model (COCOTS), collected maintenance data on 20 projects, conducted research on life-cycle cost criteria, and began development of a full life-cycle cost model.

NAS architecture research

- Completed NAS Adaptation Process Improvement (API) study. This resulted in initiation of Summary of Mission Analysis Findings for the National Airspace System Resources (NASR) System.
- Funded studies to develop a business case for consolidating projects requiring computing resources in order to reduce acquisition, operations and maintenance costs. ("Enterprise view" as opposed to "stovepipe/project specific" approach).
- Developed a proposal to leverage investments in Enroute Sustainment projects to include requirements supporting the NAS 4.0 infrastructure. (Cost and People resource savings).

Software certification research

- Initiated a Streamlining Software Aspects of Certification (SSAC) program to focus on identifying cost/schedule/quality issues in the certification of ground-based systems software components.
- R&D Partnerships:
- Constructive COTS Cost Model – University of Southern California
- COTS Guidelines – Software Engineering Institute
- Adaptation Process Improvement – Boston University
- Evolutionary Spiral Process – Software Productivity Consortium
- Partnership agreements will be initiated with EUROCONTROL, DOD, National Institute of Standards and Technology (NIST), and others.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Research on applying COTS/NDI within the NAS ground systems and avionics

- Complete Constructive COTS Cost Estimation Model and pilot the model on three FAA projects.
- Support development of COTS life-cycle management plans and life-cycle issues.

NAS architecture research

- Fund research studies to develop business cases for consolidation of projects requiring computing resources to reduce acquisition, operations and maintenance costs ("enterprise view" vs. "stovepipe/project specific").
- Conduct studies and develop prototype applications to improve efficiency of accomplishing NAS adaptation services.

Software certification research

- Continue to maintain and develop Communication, Navigation, and Surveillance/Air Traffic Management (CNS/ATM) guidelines to ensure consistency with RTCA SC 190, CNS/ATM subgroup.

KEY FY 2002 PRODUCTS AND MILESTONES:

During FY 2001, the COCOTS life-cycle model will be available for use within the FAA's Acquisition Management System. Training, workshops, and briefings will be provided on the use of COTS/NDI products in acqusitions. Electronic access to aeronautical information prototype products will be made available for field use. The SERC will act as a virtual and physical facility to coordinate completion of these

software engineering research products. Technology transfer liasons will be established with remote researchers and research sites.

FY 2002 PROGRAM REQUEST:

The software engineering research programs will build upon prior related activities conducted by the SERC and will continue to leverage resources throughout the United States, particularly those of aviation-related programs already underway at several universities. Specific work will be focused on advanced software architecture and technology applications for specific NAS Programs, and on continued end-to-end assurance of safety critical software systems.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$1,300
FY 2001 Enacted	900
FY 2002 Request	1,000
Out-Year Planning Levels (FY 2003-2006)	5,200
Total	$8,400

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Software Engineering R&D	0	462	300	900	1,000
Personnel Costs	0	538	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**1,000**	**300**	**900**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	1,000	300	900	1,000
Total	**0**	**1,000**	**300**	**900**	**1,000**

F&E 1F01 — Navigation

GOALS:

Intended Outcomes: The FAA intends to provide time efficiencies and cost savings through satellite-based navigation implementation. This technology allows direct point-to-point navigation, optimum routing, and other capacity improvements. Efficiencies and savings realized by the airlines, the traveling public, and the FAA include:

- Increased air traffic control efficiencies and NAS capacity through an airspace system that is restructured to accommodate direct routings between airports, as well as reduced separation standards.
- Reduced fuel cost to airlines and reduced travel time to the public through use of more economical air routes.
- Reduced FAA operating costs through the potential decommissioning of existing ground-based navigation equipment.
- Simplified Global Positioning System (GPS) augmentation infrastructure through introduction of wide area and local area interoperability that provides satellite navigation services at a reduced cost.

Agency Outputs:

Wide Area Augmentation System (WAAS)

The FAA uses the National Satellite Test Bed (NSTB) as the foundation for all current research and development activities associated with implementing the Wide Area Augmentation System (WAAS). The NSTB is essential to the development and implementation of Global Positioning System (GPS) and its WAAS augmentations. Findings from the NSTB help the FAA develop required user equipment through avionics manufacturers, continue development of GPS user procedures, and gain international acceptance of a seamless Global Navigation Satellite System (GNSS).

Using the NSTB as a prototype system, the program is developing and implementing the capability to monitor and evaluate system performance of both the basic GPS service and the WAAS during implementation activities. During these evaluations, large quantities of complex technical data will be collected, analyzed, and archived.

The data will be made available to the FAA and other Government Agencies (as well as to industry, academia, and international entities) to facilitate information exchange, foster cooperation around the world, and achieve a seamless global air navigation system.

The results of this “live” data collection and analysis will assist the FAA in: (1) analyzing and defining the satellite-based navigation technology requirements of air traffic and airway facilities; and (2) determining connectivity and interoperability requirements for international augmentation systems being developed by other countries. The information obtained from these performance evaluations will also allow the FAA to monitor the WAAS system contractor performance.

When the Phase I WAAS becomes operational, the FAA plans to approve the use of GPS as a primary means of navigation for en route through non-precision approaches. Initial WAAS capability will provide Lateral Navigation/ Vertical Navigation (LNAV/VNAV) capabilities. Future phases of WAAS are expected to provide precision approach capabilities which will increase the numbers of airfields with a precision approach capability, and potentially enable the decommissioning of some existing ground-based navigation equipment throughout the U.S.

Local Area Augmentation System (LAAS)

The Local Area Augmentation System (LAAS) Test Prototype (LTP) system is being used to test and validate the expected performance of LAAS systems. The LAAS is intended to complement the WAAS, and the systems function together to supply users of the NAS with seamless satellite-based navigation for all phases of flight. The LAAS will be used to meet Category I Precision Approach requirements at those locations where WAAS is unable to meet those requirements. LAAS will also be used to meet the more stringent Category II/III requirements at selected locations throughout the U.S. LAAS will yield the extremely high accuracy, availability, and

integrity necessary for Category II/III precision approaches. It is fully expected that the end-state configuration will pinpoint an aircraft's position to within one meter or less.

The FAA has developed and provided a functional Category I LAAS specification, architecture, and Minimum Operational Performance Standards (MOPS) to industry for implementing local area systems across the United States. The FAA will validate the capability to perform Category II/III precision approaches through continued research and development efforts associated with the LAAS Program. An LTP has been developed, and is being used to conduct nationwide flight tests in cooperation with several end-state users of LAAS technology including United Parcel Service (UPS) and Federal Express (FedEx).

Customer/Stakeholder Involvement:

The program's implementation strategy involves other government agencies, industry, and academia.

The FAA has established and continues to actively participate on various teams addressing immediate needs for operational implementation issues. These include the Satellite Operational Implementation Team (SOIT), Satellite Procedures Implementation Team, Air Traffic SOIT (ATSOIT), and many other Teams and working groups.

The FAA has also founded the Technical Interoperability Working Group (IWG) in which the developers of all worldwide Satellite Based Augmentation Systems (SBAS) [U.S. WAAS, the European Geostationary Navigation Overlay Service (EGNOS), Japan MTSAT Satellite Based Augmentation System (MSAS), and Canadian WAAS] meet on a periodic basis to identify and address potential technical barriers to seamless travel between any of these systems. These meetings began in 1997 and are expected to continue until approximately 2001-02.

The FAA works cooperatively with the Positioning and Navigation Executive Committee, the Joint Precision Approach and Landing System Program, and the Department of Defense to establish and promote a national consensus on GPS management and operation. The FAA also provides active support to the Interagency GPS Executive Board (IGEB) regarding overall GPS modernization issues.

Accomplishments:

On September 2, 1999 the FAA Joint Resource Council (JRC) meeting was held to decide the future direction of satellite navigation programs. This forum also considered information from the recently performed and congressionally mandated Investment Analysis (IA). The JRC reaffirmed the FAA's commitment to satellite-based navigation; approved the WAAS Acquisition Program Baseline (APB); approved additional satellite leasing preparatory activities; and approved the LAAS Acquisition Program Baseline, including quantities and schedule changed as the result of this IA, increasing from 143 to 160 systems.

WAAS

The development of WAAS has continued to achieve many significant program milestones. In FY 00, WAAS successfully completed a milestone stability test. The WAAS signal-in-space continues to provide accuracies well within the range required by the WAAS specification.

To support the expansion of WAAS to the Caribbean and South American Region (CAR/SAM) region, the FAA has secured letters of intent from Mexico and Panama for participation in the operational U.S. WAAS. Additionally, both countries signed bilateral agreements for the installation of NSTB reference stations to be used to prepare for the installation of operational WAAS reference stations in the near future. Related uses of the reference stations include pre-operational support, technology familiarization, flight tests, certification activities, procedure development, and siting analyses. These agreements will significantly cut the FAA's expenses by reducing the agency's need to field WAAS reference stations along the southern U.S. border.

In addition, the FAA has assisted the International Civil Aviation Organization (ICAO) with plans and strategies for the development of a WASS/LAAS-based GNSS test bed capability for the CAR/SAM region. The resulting South American Test Bed (SATB) will pave the way for

an operational system in the region that is completely compatible with the U.S. systems. This future capability, based on U.S. technology, will also provide cost-sharing opportunities on GEO satellite services, significantly reducing projected FAA leasing expenses for end-state WAAS GEOs.

The successful completion of all flight tests and other activities helped to: (1) demonstrate U.S. technological leadership in satellite navigation; (2) ensure the seamless transfer from one regional satellite-based navigation system to another; (3) promote the adoption of satellite navigation in regions where improved navigation capability will increase the safety of flight for U.S. citizens traveling abroad. WAAS will provide the groundwork necessary to achieve the International Civil Aviation Organization's vision of a future, worldwide, seamless, navigation capability.

LAAS

Research and development activities to use LAAS to achieve Category I and Category III precision approaches progressed substantially through the use of the LAAS Test Prototype. Tests using the LTP were completed with excellent results at various locations around the nation.

In August 1999, the FAA, in conjunction with UPS and the Air Transport Association (ATA), conducted approximately 40 precision approaches using a wide-body aircraft and the LTP. These tests had very positive results for the use of LAAS and its pseudolite technology on wide-body aircraft. All previous tests were conducted on narrow-body aircraft.

In October 1999, the FAA, in conjunction with FedEx and ATA, conducted further wide-body flight testing at Memphis International Airport. The purpose of these tests was to verify the reception of the airport pseudolite (APL) signal by a wide body aircraft (MD-10) and the ability to accurately range from that signal. A total of 45 precision LAAS approaches were conducted to all six runway ends. Results of the test indicated the typical horizontal Navigation System Error (NSE) estimate was less than one meter, and the vertical NSE was less than two meters. These results are well within LAAS requirements. These successful flight tests demonstrated the potential of this new technology and the significant contribution LAAS will make to the advancement of satellite-based aviation.

The LAAS Integrity Monitoring Test Bed (IMT) is another tool currently being utilized to validate LAAS requirements and performance. The final version is expected to be deployed at San Francisco International Airport for ground data collection.

Furthermore, LAAS Category I development is proceeding forward. Government Industry Partnerships (GIP) reflecting this effort were signed with Honeywell and Raytheon in April 1999. The LAAS Category I Specification was finalized and approved in September 1999. The Category I MOPS is expected to be approved by February 2000. Category II/III research and development efforts are continuing. LAAS development is ongoing with an initial public use expected for 2003 for Category I and late 2005 for Category III. Work has begun on a LAAS siting document.

R&D Partnerships:

The FAA has approximately 20 grants, interagency agreements, and contracts in place with industry, academia, and other government agencies to leverage their expertise and capabilities in satellite navigation R&D. Principal participants include Stanford University, Ohio University, the Naval Air Warfare Center Aircraft Division (NAWCAD), and the Central Intelligence Agency (CIA).

In addition, 15 cooperative bilateral agreements are in place, with additional agreements currently in progress, to facilitate and promote the communication and information transfer for a seamless global navigation satellite system.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Perform data collection and analyses using the NSTB to further develop WAAS performance-assessment capabilities.
- Support developing WAAS antenna interference mitigation and rejection methods, a safety processor to meet FAA safety assur-

ance standards, and analyze satellite alternatives for WAAS final operating capability.

- Continue to conduct ionosphere data collection and analysis to define WAAS final operational capabilities.
- Continue research into signal quality monitoring, operations and maintenance, flight control monitoring, and automatic dependent surveillance with participation from Stanford and Ohio Universities.
- Continue investigation studies and analysis for surface movement guidance, helicopter operations, and advanced LAAS augmentations using pseudolites.
- Continue to develop and mature the LAAS integrity algorithms.
- Continue installing and testing of LAAS prototype systems at several sites to ensure that the systems will validate the functional specification in particularly difficult sites.
- Continue to demonstrate and test international connectivity as a transition to a seamless global navigation system.
- Continue to coordinate with ICAO to produce Standards and recommendation Practices (SARPS) to define LAAS in the international community.
- Continue interference analysis to identify and mitigate potential threats.
- Continuation/Completion of LAAS Category I Specification Validation efforts.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Define optimum SATNAV architecture for Alaska.
- Investigate satellite anomalies.
- Perform time transfer studies for SBAS interoperabillity.
- Develop WAAS performance monitoring and assessment capabilities.
- Define and test SBAS interoperability scenarios.
- Characterize peak solar cycle in support of developing a WAAS ionospheric algorithm for future phases of WAAS.
- Develop interference detection and mitigation techniques.
- Analyze impact of additional civil frequencies.
- Validate LAAS Category I Integrity.
- Develop LAAS Category III requirements for autoland.
- Further refine FAA LAAS Category II/III test prototype.
- Develop and validate LAAS Category III Specification.
- Validate LAAS Category II/III Integrity Monitoring.
- Develop Improved Signal Quality Monitoring Techniques for CAT III LAAS.
- Investigate Ephemeris Monitoring requirements for CAT III LAAS.
- Develop ICAO SARPS Standards for Category II/III LAAS.
- Develop Airport Pseudolite Integration Techniques.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program request of $5.7M will focus on developing and implementing GPS augmentations to further the transition to satellite-based navigation technology. Efforts will focus on research and analysis of issues associated with WAAS accuracy, integrity, and availability to the users, with specific emphasis on the ionosphere and interference to ensure integrity and continuity of service. Current research efforts will focus on better utilization of present and future global navigation satellite systems, analysis of LAAS VHF data broadcast characteristics and LAAS category I/II/III evaluations at various locations across the country.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$17,895
FY 2001 Enacted	6,900
FY 2002 Request	5,700
Out-Year Planning Levels (FY 2003-2006)	24,100
Total	$54,595

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Navigation	0	* 10,718	4,900	6,900	5,700
Personnel Costs	0	2,277	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**12,995**	**4,900**	**6,900**	**5,700**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	12,995	4,900	6,900	5,700
Total	**0**	**12,995**	**4,900**	**6,900**	**5,700**

*** Contract amount includes $4.0M for Low Cost Next Generation Precision Gyroscope Technology earmarked by Congress.**

Navigation Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Navigation							
Wide Area Augmentation System (WAAS)	$2,900						
Perform Data Collection and Analyses Using the National Satellite Test Bed (NSTB) to Further Develop WAAS		◆	◇	◇	◇	◇	◇
Continue to Conduct Ionosphere Data Collection and Analysis to Define WAAS Final Operational Capabilities and Support the Development of Enhanced WAAS Ionospheric Algorithm		◆	◇	◇	◇	◇	◇
Define Optimum Architecture for Alaska		◆	◇	◇	◇	◇	◇
Investigate Satellite Anomalies							
Continue Interference Analysis to Identify and Mitigate Potential Threats		◆	◇	◇	◇	◇	◇
Develop WAAS Performance Monitoring and Assessment Capabilities		◆	◇	◇	◇	◇	◇
Define Assumptions and Parameters for Worldwide Service Volume Model							
Perform Interoperability Analyses to Support Seamless Global Navigation Satellite System (GNSS)							
Local Area Augmentation System (LAAS)	$2,800						
Validate LAAS Category I (CAT I) Integrity		◆	◇	◇	◇	◇	◇
Develop LAAS CAT II/III Algorithm		◆	◇	◇	◇		
CAT II/III Implementation and Testing		◆		◇	◇	◇	◇
Develop Improved Signal Quality Monitoring Techniques for CAT III LAAS		◆		◇	◇	◇	
Develop Improved Integrity Algorithms for CAT III LAAS		◆				◇	◇
Investigate Ephemeris Monitoring Requirements for CAT III LAAS							
Develop Airport Pseudolite Integration Techniques							
Total Budget Authority	**$5,700**	**$6,900**	**$5,700**	**$5,900**	**$6,000**	**$6,100**	**$6,100**

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01— Surveillance

GOALS:

Intended Outcomes: The FAA plans to improve system efficiency and safety by implementing a low-cost surveillance system that enables Free Flight capabilities and enhances safety and efficiency. This program develops domestic and international Automatic Dependent Surveillance - Broadcast (ADS-B) standards to facilitate global system interoperability. It also evaluates specific applications and technologies of ADS-B to support standards development.

ADS-B uses an onboard Global Navigation Satellite System (GNSS) receiver or other backup source of navigation data to derive the altitude and position of an ADS-B-equipped aircraft. These data and aircraft identity are broadcast directly to ground receivers as well as to nearby aircraft. An ADS-B message displayed on a neighboring aircraft's airborne Cockpit Display of Traffic Information (CDTI) facilitates the flight crew's situational awareness, conflict detection, and Free Flight capabilities. The ground receivers can provide the information to ATM facilities and other users.

The ADS-B technology's modular design and cooperative nature offer a low cost alternative to the surveillance coverage in existing nonradar areas, and potentially, in some areas currently served by radars. Through accurate and timely updates directly to pilots, the system offers the potential to reduce current separation standards while still improving overall safety, efficiency, and airspace capacity.

Agency Outputs: Current efforts focus on developing standards for the system's avionics, its applications, and display (CDTI) system. Standardization efforts include RTCA minimum aviation system performance standards (MASPS), minimum operational performance standards (MOPS), technical standard orders, and design criteria. Analyses and evaluations will be conducted to provide technical inputs to RTCA MASPS/MOPS on ADS-B links, airborne surveillance and separation assurance processing, and other surveillance system sources necessary to support ADS-B applications. International standards such as the International Civil Aviation Organization's (ICAO) Standards and Recommended Practices (SARPS) will also be developed. These standards must be developed and maintained in order for the designs of avionics, ground and other systems to be compatible and capable of operating together.

Customer/Stakeholder Involvement: Air carrier and general aviation user communities have asked for FAA leadership in developing ADS-B technology. The FAA and the user community are actively involved in the standards development activity at RTCA SC 186. Some of the specific stakeholders include the Cargo Airline Association, Air Transport Association, Airline Pilots Association, Aircraft Owners and Pilots Association, United Airlines, Northwest Airlines, avionics manufacturers, ICAO panels, and the European Work Group on ADS-B.

Accomplishments: Draft ADS-B avionics standards development continues at RTCA. Analysis and simulation have been conducted to complete the technical standards development. Flight test of 1090 MHz ADS-B has been completed in US and Germany. Specific accomplishments include:

- Completed a significant portion of ADS-B 1090 MHZ MOPS
- Completed a significant portion of ADS-B/ CDTI MOPS for selected applications
- Completed a flight test of 1090 MHz ADS-B at Frankfurt, Germany, one of world's highest interference environments.
- Completed a technical report on the results of the flight test of 1090 MHz ADS-B at Los Angeles basin. Flight test data and analysis results have been incorporated in ADS-B MOPS.

R&D Partnerships: The joint government/ industry committee, RTCA SC 186, is tasked with achieving R&D consensus on system standards for ADS-B. Massachusetts Institute of Technology Lincoln Laboratory, MITRE, Federal Aviation Administration Technical Center (FAATC) and NASA are also jointly involved in the technical development and integration of ADS-B technology into the NAS.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Completed development of ADS-B 1090 MHz Minimum Operation Performance Standards (MOPS) with RTCA (Version 1).
- Developed initial draft of ADS-B/CDTI Minimum Operational Performance Standards (Version 1).
- Initiated RTCA ADS-B MOPS on Universal Access Transceiver (UAT).
- Initiated RTCA ADS-B MOPS on Version 2 of 1090 MHz.
- Initiated RTCA MOPS on Traffic Information System-Broadcast (TIS-B).
- Completed report on flight test of ADS-B 1090MHz at Frankfurt, Germany.
- Completed ADS-B Master Plan/Roadmap.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Provide update to RTCA ADS-B 1090 MHz MOPS (Version 2) and ICAO SARPS on extended squitters.
- Complete Version 1 of RTCA ADS-B MASPS on Airborne Separation Assurance (ASA).
- Complete draft RTCA ADS-B MOPS on UAT.
- Complete Version 1 of RTCA TIS-B MASPS.
- Continue work on Airborne Surveillance and Separation Assurance Processing (ASSAP) MOPS.

FY 2002 PROGRAM REQUEST:

The FAA and RTCA will continue to update the RTCA ADS-B 1090 MHz MOPS. Analysis will be conducted to complete Version 1 of the RTCA ASA MASPS. The draft MOPS on UAT will be completed. Additionally, updates to the RTCA MASPS on TIS-B will be completed. Development of the ASSAP MOPS will continue.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$6,190
FY 2001 Enacted	2,600
FY 2002 Request	2,800
Out-Year Planning Levels (FY 2003-2006)	8,900
Total	$20,490

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Surveillance	0	3,506	1,900	2,600	2,800
Personnel Costs	0	784	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**4,290**	**1,900**	**2,600**	**2,800**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	4,290	1,900	2,600	2,800
Total	**0**	**4,290**	**1,900**	**2,600**	**2,800**

Surveillance Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Automatic Dependent Surveillance-Broadcast (ADS-B)							
Plans, Standards, and Analysis							
Minimum Operational Performance Standards (MOPS) and Standards and Recommended Practices (SARPs)	$2,800						
Provide Initial RTCA UAT MOPS		◆	◇				
Update RTCA UAT MOPS			◇	◇	◇		
Provide and Update ASA MASPS and ASSAP MOPS		◆	◇	◇	◇	◇	
Provide Technical Support to RTCA MASPS on Traffic Information System – Broadcast (TIS – B)		◆	◇	◇	◇		
Update RTCA MOPS on 1090 MHz		◆	◇	◇			
Update ICAO SARPs and Documents on Extended Squitters		◆	◇	◇			
Analyze Architecture of Multi-Link ADS – Ground Station				◇	◇		
Develop ADS – B Master Plan		◆	◇				
Develop high – Fidelity Simulation & Validation Plan for ADS - Applications		◆	◇				
Integrate ADS-B/Radar Data with Ground Automation					◇	◇	◇
Total Budget Authority	$2,800	$2,600	$2,800	$1,500	$2,000	$2,000	$3,400

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Airspace Management Laboratory

GOALS:

Intended Outcomes: The mission of the Air Traffic Airspace Management Program Office (ATA) is to ensure that the sectorization and routes are designed for the safest and most efficient use by operators, while maintaining diligent consideration for local and national environmental policy, to meet the demand for air transportation.

The ATA Airspace Laboratory serves to support that mission by providing detailed, quality information through the creation of databases, simulation modeling for the analysis and reporting or presentation aids for ATA and Region management and specialists, and development of information systems for, and data requests by, other FAA lines of business as resources permit.

Major caterories of activities carried out by the Laboratory include:

- Identify issues and perform analyses, with appropriate attention to potential environmental impact in support of the ATA airspace assessment and redesign activities. This includes the continuing development of data management and simulation tools for the evaluation of airspace design alternatives by FAA field personnel and Federally Funded Research and Development Center (FFRDC) analysts.
- Develop information system applications to support other FAA lines of business dependent on extensive operational data such as overflight "fee for service" assessments and obstacle awareness and evaluation.
- Serve as the agency's repository and redistribution center for the regular reporting and research applications of air traffic operational activity data. For example, the Laboratory currently provides Enhanced Traffic Management System (ETMS) data to various FAA offices, including the Consolidated Operations and Delay Analysis System and the Daily Measurement of Air Traffic Service.

Information products provided on a regular basis during the past year include:

- Acquisition, storage, distribution, and information extraction of air traffic operational data.
- Quantitative analysis of current air traffic activity including some performance measures such as reported cancellations, diversions, and delays.
- Environmental (noise) analyses.
- Development of the following information systems:
  - Obstruction evaluation database.
  - Overflight "fee for service" assessments.
  - Foreign Overflight Notification System (for DOD).
  - The Consolidated Operations and Delay Analysis System (CODAS).
  - The Daily Measurement of Air Traffic Service (DMATS).

Customer/Stakeholder Involvement:

Successful demonstration of the capabilites of the ATA Laboratory has been shown to have value and even greater protential value across several FAA lines of business. In addition to the Airspace Management Program Office, the Office of System Architecture and Investment Analysis (ASD), the Office of System Capacity (ASC), Air Traffic Planning and Procedures (ATP), and Air Traffic System Management (ATM), the Lab has supported the missions of the Cost Accounting Team, the Office of Financial Services, the Office of Aviation Policy, and the Y2K Contingency Planning Work Group.

The Laboratory also has provided ongoing support for numerous projects of the FAA Eastern Region (AEA) involving field analyst staffing, analytical work, daily access to operational data, and continuing technical support for database query programming.

The ATA Laboratory has been identified as the element responsible for supporting airspace design dependencies for FAA Facilities and Equipment (F&E) programs with broad government and industrial involvement, including:

- Local Area Augmentation Systems (LAAS)

– all category approaches.

- Low Altitude Direct Routing using Wide Area Augmentation Systems (WAAS).
- Runway Incursion Program.
- WAAS Precision Approaches.
- Automatic Dependent Surveillance (ADS) studies.
- Single and Multi-center metering.
- Final Approach Spacing Tool (FAST) implementation studies.
- New Host Consolidation/Dynamic Resectorization studies.

Accomplishments:

Airspace issue identification

- Tracked critical parameters for proactive identification of issues.
- Visualized/analyzed past and current traffic patterns.
- Analyzed system performance.

Airspace design and environmental evaluation

- Developed alternative airspace designs for examination.
- Analyzed changes to airspace design on flow, capacity, delay, workload, and other metrics as required.
- Developed data necessary to evaluate noise and consider pollution impacts to complement airspace design analysis.

R&D Partnerships: Organizations that will use or support the laboratory include the Office of System Architecture and Investment Analysis (ASD), the Office of System Capacity (ASC), Air Traffic Planning and Procedures (ATP), and Air Traffic System Management (ATM).

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Developed national listing of aircraft diversions.
- Developed New York and Washington metro area arrival and departure fix reports.
- Provided analytical support with two operational studies:
  – Compari
  – son of sector densities from four Aircraft Management Program (AMP)-based systems—OAMP, HAME, Staffing to Traffic (STT), and PCOAT.
  – Review of the STT data (Input Data, Air Traffic Activity Measures, and Output Reports). (See CNAC reports CRM 95-22 and CRM 94-128.)
- Performed analytical work/studies on behalf of Eastern Region.
- Provided Sector Design Analysis Tool (SDAT) support with sector analysis studies.
- Developed concept papers on a range of topics, including:
  – Concept for a Field-Level Traffic Management Unit Operational Test, Evaluation and Development Capability.
  – En Route Sector Spacing Tool.
  – Smart Log and Lessons Learned.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Continue collection and management of data from air traffic operations in support of the following:
- Analyze and report Current NAS Traffic Activity.
- Begin Integration of local and regional airspace design concepts into a system-wide national level scope.
- Support environmental studies, especially noise related.
- Support the examination of technologies being acquired or alternative procedures with respect to potential for Air Traffic Control (ATC) efficiency and other performance- related improvements.
- Continued development of information systems as demanded by several FAA lines of business.

FY 2002 PROGRAM REQUEST:

Significant changes in avionics and air traffic control technology, coupled with continuing changes in the type, amount, and distribution of traffic, have created a need to study and redesign the nation's airspace for current and future use. It is particularly likely that airspace redesign will be

required to complement FAA's implementation of global positioning navigation systems, Free Flight, and related dynamic sectorization. While airspace changes have been analyzed and implemented for decades at the local level, a systematic, comprehensive national analysis has not been performed. An overall approach to a national design is being developed.

The above described activities serve to demonstrate the proven technical capability in prototype form. The need to develop this capability into a full-scale mission capability has been validated by FAA Mission Need Statement #331. Acquisition analysis and planning will begin following a detailed definition of the full-scale requirements beginning in FY 2001.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$3,000
FY 2001 Enacted	4,000
FY 2002 Request	4,500
Out-Year Planning Levels (FY 2003-2006)	27,600
Total	$39,100

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Airspace Management Lab	0	0	3,000	4,000	4,500
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**3,000**	**4,000**	**4,500**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	3,000	4,000	4,500
Total	**0**	**0**	**3,000**	**4,000**	**4,500**

F&E 1F01 — Separation Standards

GOALS:

Intended Outcomes: The Separation Standards Program works to reduce separation standard values within international airspace to make the following benefits available to providers and users of oceanic air traffic control systems:

- Increased system efficiency—evidenced through reduced aircraft fuel-burn and transit times.
- Increased theoretical system capacity—evidenced through an increase in the number of routes and flight levels controllers can safely support within the same volume of airspace.
- Increased international standardization of separation criteria and resultant enhanced system safety.

Agency Outputs: The FAA's "Strategic Plan for Oceanic Enhancements and Separation Reductions" describes a systematic process for revising international separation values and establishes priorities for such changes. To document and evaluate each separation change, the FAA produces a series of supporting products:

- Operational assessments of the value the change brings to Air Traffic Control (ATC) system providers and users.
- Benefit-cost analysis regarding the change.
- Safety assessment of the system before and after application of the separation change.
- Publication of FAA regulatory material required by the change.
- Completion of any new rulemaking required by the change.
- Development of ATC procedures required by the change.
- Development of any new or changed International Civil Aviation Organization (ICAO) guidance material, annexes, or regional supplementary procedures required to standardize and make the reduced separation value safe for international operations.
- Establishment and maintenance of any long-term safety oversight functions required for the implementation and continued safe use of the reduced separation value.

Customer/Stakeholder Involvement: The Separation Standards Program establishes appropriate ICAO-government-industry forums to draw all parties concerned with a change in separation standards into a common process. The cooperating entities may include: state Civil Aviation Authorities (CAA), ICAO Regional and Headquarters elements, ATS providers, ATC system users, industry trade organizations, and unions representing controllers and pilots.

Participants in specific change processes include:

- Pacific separation standards. Changes proceed with the coordination and endorsement of the (North Pacific) Oceanic Work Group, Informal (North) Pacific ATC Coordinating Group, and Informal South Pacific ATS Coordinating Group, as well as the ICAO Pacific Reduced Vertical Separation Minimum (RVSM) Task Force.
- North Atlantic separation standards. Changes are carried out through the ICAO Regional Planning Group, the North Atlantic Systems Planning Group.
- West Atlantic Route System Separation Standards (WATRS). Proposed improvements involve participation of the New York Oceanic Capacity Enhancement Task Force.
- Gulf of Mexico and Caribbean Separation Standards. Proposed changes involve participation of the Gulf of Mexico Work Group and the ICAO CAR/SAM Regional Planning and Implementation Group (GREPECAS) group.
- The program also provides FAA representation on ICAO's Review of the General Concept of Separation Panel (RGCSP)—the focal point for development of the technical justification for new separation minima as well as the forum for assessing application of recommended ICAO separation practices on a global and regional basis.

Accomplishments: The Separation Standards Program has been the vehicle for the FAA to bring about major reductions in separation standard values affecting international airspace.

In the past three years, the program has been responsible for several significant changes:

- North Atlantic RVSM, or 1000-ft. vertical separation standard above flight level (FL) 290 (March 1997). Introduction of this change marked the culmination of a 15-year effort by the FAA and other State CAAs to reduce the high-altitude separation standard. Several studies had predicted that the RVSM would be the single most cost-beneficial separation change possible for oceanic airspace; actual experience has proven that the studies were accurate forecasters of RVSM benefits. Within the first 12 months after RVSM implementation, each of the 10 operators accounting for a combined 60 percent of annual North Atlantic operations had recovered the sunk costs associated with bringing its aircraft into compliance with RVSM requirements.
- Northern Pacific 50-nm lateral separation standard based on operator compliance with Required Navigation Performance (RNP)-10 requirements (April 1998; December 1998; and February 2000). This linkage between a separation standard and an RNP value marked the first use of the ICAO-endorsed concept in any portion of worldwide airspace. The change has led to measurable improvements in both ATC operations and aircraft fuel-burn and transit time.
- North Atlantic Implementation Management Group Cost Effectiveness (NICE) Program (October 1999). This comprehensive fast-time-simulation-based assessment of the benefits associated with North Atlantic separation changes proposed through the year 2010 resulted in significant changes. Plans were modified for ATS system infrastructure expenditures and users were held to different schedules and equipage requirements in order to participate in the project within the airspace. The FAA's NICE Program contributions were the result of a combined effort by federal staff members and grant-sponsored university researchers.
- Pacific RVSM (February 2000). Based on FAA encouragement, contributions, and previous experience in the North Atlantic, the ICAO Asia and Pacific Region planning group established the Pacific RVSM Task Force which oversaw successful implementation of the RVSM in February 2000. The FAA chaired or co-chaired all Task Force working groups and provided the technical consultation concerning RVSM implementation to states in the region. The ICAO Asia Pacific Region planning group agreed that the FAA Technical Center would provide the safety oversight function associated with RVSM implementation and endorsed establishment of the Asia/Pacific Approvals Registry and Monitoring Organization (APARMO) to carry out this function.

R&D Partnerships: The Separation Standards Program provides FAA representation to ICAO's RGCSP, the principal global forum for moving ahead with the development of new separation minima. The FAA and other CAAs typically cooperate in such work, with each state-participant freely sharing research results within the Panel. In addition, the Separation Standards Program maintains close research ties with academia through sponsorship of grants and cooperative work with Rutgers University in the development of large fast-time simulation models of oceanic airspace. The program also has a direct link with international separation research activities in which the FAA's GPS Monitoring System supports EUROCONTROL's RVSM safety oversight activities. In turn, that international body provides access to the products of its RVSM research.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Emphasis in FY 2001 will be in four major areas:

- Pacific RVSM: expansion of the RVSM upper stratum from FL 390 to FL 410 throughout the Pacific.
- Development and acceptance by ICAO of requirements for 30-nm lateral separation standard based on automatic dependent surveillance in oceanic and remote airspace.
- Preparations for November 2001 implementation of RVSM in the West Atlantic Route System.

- Establishment of a comprehensive plan to introduce RVSM and horizontal–plane separation reductions in the Gulf of Mexico and the ICAO Caribbean/South American Region.
- Initiation of work to introduce NICE simulation methodology into Pacific system planning and analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Implement the West Atlantic Route System RVSM in November 2001.
- Complete work within RGCSP to formalize implementation requirements for 30-nm lateral and 30-nm longitudinal separation standards.
- Implement plan formulated in FY 2001 to reduce separation minima in Gulf of Mexico and ICAO Caribbean/South American Region.
- Continue to provide a safety oversight function in Pacific and North Atlantic.
- Finalize of NICE work to quantify North Atlantic communication requirements associated with reduced separation minima.
- Production of preliminary Pacific airspace planning and analysis methodology-based upon NICE developments.

FY 2002 PROGRAM REQUEST:

The FY 2002 program request provides for:

- Completion of real-time simulation, procedure development and safety oversight activities necessary to permit November 2001 introduction of RVSM into the West Atlantic Route System.
- Completion of work necessary to finalize implementation requirements for reducing horizontal-plane separation minima to 30-nm—with such requirements anticipated as satisfied by Automatic Dependent Surveillance.
- Expansion of safety oversight assistance beyond the Pacific and North Atlantic, including augmentation of the GPS Monitoring System to support Gulf of Mexico, Caribbean/South American, and possible NAS RVSM implementation.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$2,545
FY 2001 Enacted	2,200
FY 2002 Request	2,200
Out-Year Planning Levels (FY 2003-2006)	10,500
Total	$17,445

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Separation Standards	0	0	1,400	2,200	2,200
Personnel Costs	0	* 1,145	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**1,145**	**1,400**	**2,200**	**2,200**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	1,145	0	0	0
Development (includes prototypes)	0	0	1,400	2,200	2,200
Total	**0**	**1,145**	**1,400**	**2,200**	**2,200**

*** In FY 1999 in-house costs for Separations Standards Project was included in System Capcity, Planning and Improvements budget item.**

Separation Standards Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Separation Standards							
West Atlantic Route System (WATRS) Reduced Vertical Separation Minima (RVSM)	$200						
Conduct Safety Oversight				◇	◇	◇	◇
Develop Procedures		◆	◇				
Implement		◆	◇	◇	◇	◇	◇
Complete North Atlantic Implementation Management Group Cost Effectiveness (NICE)	$200						
Develop Final Recommendations		◆	◇				
		◆	◇	◇	◇	◇	
Pacific RVSM	$300						
Implement Fully		◆					
Conduct Safety Oversight		◆	◇	◇	◇	◇	◇
30–nm lateral/30-nm Longitudinal Separation	$300						
Develop Requirements		◆	◇				
Implement Changes					◇	◇	◇
Gulf of Mexico and Caribbean Separation Changes	$1,000						
Developed Requirements		◆					
Develop Procedures		◆					
Implement Changes			◇	◇	◇	◇	◇
Pacific System Analysis	$200						
Modify NICS Model		◆	◇	◇			
Develop Recommendations		◆	◇	◇	◇	◇	
Total Budget Authority	$2,200	$2,200	$2,200	$2,400	$2,500	$2,500	$3,100

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Domestic Reduced Vertical Separation Minima

GOALS:

Intended Outcomes: The Domestic Reduced Vertical Separation Minima (DRVSM) Program is working to reduce the separation standard within the domestic airspace of the continental United States, in order to achieve the following benefits for providers and users of the domestic air traffic control system:

- Increased system efficiency through reduced fuel-burn and decreased delays.
- Increased theoretical system capacity through increased capability of controllers to support greater numbers of routes and flight levels safely within the same airspace.

Agency Outputs: The DRVSM Plan decribes a systematic process for revising domestic separation standards between FL290 and FL410 and establishes priorities for such changes. To document and evaluate each separation change, the FAA produces the following supporting products:

- Operational assessments of the value the change brings to providers and users of the Air Traffic Control (ATC) system.
- A benefit-cost analysis regarding the change.
- A safety assessment of the system before and after application of the change.
- Publication of FAA regulatory material required by the change.
- Completion of any new rulemaking required by the change.
- Development of ATC procedures required by the change.
- Development of any new or changed guidance material and procedures required to standardize and make the reduced separation standard safe for domestic operations.
- Establishment and maintenance of any long-term safety oversight function required for the implementation and continued safe use of the reduced separation standard.

Customer/Stakeholder Involvement: The DRVSM Program creates appropriate government-industry forums to draw all concerned parties into a common process. The cooperating entities include: DOD, Canada, ATS providers, ATC system users, industry trade organizations, and unions representing controllers and pilots.

Accomplishments: The DRVSM Program is the vehicle for the FAA to effect major reduction in separation standards affecting domestic airspace within the United States. This recently funded program has established a comprehensive plan for the implementation of its objectives. Fast-time simulations were conducted for a preliminary assessment of benefits. An industry day seminar was conducted for users, who included representatives identified as customers/ stakeholders.

R&D Partnerships: Colorado State University has teamed with the program to investigate the impact of mountain wave activity on DRVSM. A relationship also was stablished with EUROCONTROL to collect and anaylyze data related to RVSM in Europe.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Conducted a cost-benefit analysis.
- Examined the operational factors and controller workload associated with implementation of DRVSM via human-in-the-loop simulations.
- Developed and deployed a monitoring system and established North American Approvals Registry and Monitoring Organizaion.
- Performed rulemaking for the implementation of DRVSM .
- Conducted DRVSM seminar for customers and stakeholders.
- Developed pilot procedures for application within DRVSM airspace.
- Developed ATC procedures for use within DRVSM airspace.
- Developed procedures for handling mountain wave activity within DRVSM airspace.
- Began an initial safety analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Assess the impact of DRVSM implementation on NAS automation systems and plan for upgrades/modifications.
- Continue simulations to test newly developed ATC procedures and report on simulation results.
- Continue work on the safety assessment.
- Develop and test acceptable ATC procedures for non-approved military aircraft to transit DRVSM airspace.
- Continue the rulemaking process.

FY 2002 PROGRAM REQUEST:

The FY 2002 program request provides for:

- The conduct of real-time simulation and safety assessments necessary to progress the DRVSM Program towards implementation.
- Analyses of the outcomes and implications of completed real-time simulations and safety assessments.
- The development of procedures based on an operational understanding of real-time simulation and safety assessment analyses.
- The continuation of tasks necessary in the rulemaking process for the phased implmentation of DRVSM beginning in December 2004.
- Expansion of the collaborative effort with academia, users and providers of ATC services and the aviation industry to ensure understanding, and acceptance of DRVSM benefits.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$0
FY 2001 Enacted	0
FY 2002 Request	2,100
Out-Year Planning Levels (FY 2003-2006)	*
Total	$2,100

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Domestic Reduced Vertical Separation Minima	0	0	0	0	2,100
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**2,100**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	0	2,100
Total	**0**	**0**	**0**	**0**	**2,100**

Note: FY 2002 is the first year of funding under Facilities and Equipment Advanced Technology Development and Prototyping.

*** Out year funding under review**

Domestic Reduced Vertical Separation Minima Program Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Domestic Reduced Vertical Separation Minima							
DRVSM	$2,100						
Conduct Role Making			◇				
Conduct Safety Assessment			◇	◇	◇	◇	
Develop Database			◇	◇	◇	◇	◇
Develop Monitoring Procedure			◇				
Conduct Modeling and Simulations			◇	◇			
Conduct Analysis of Data			◇	◇			
Develop Procedures			◇				
Total Budget Authority	$2,100		$2,100	*	*	*	*

Notes:
– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.
– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

* Out Year Funding Request Under Review. FY 2002 is the First Year of Funding under Facilities and Equipment Advanced Technology Development and Prototyping.

F&E 1F01— NAS Requirements Development

GOALS:

Intended Outcomes: This program will support mission analysis (MA) and NAS requirements development efforts. It will fund studies and other efforts to prepare and validate strategies and proposals designed to increase overall NAS efficiency. Also, it will support the FAA System Efficiency mission goal to "*provide an aerospace transportation system that meets the needs of users and is efficient in the application of FAA and aerospace resources*."

As part of the Agency's Acquisition Management System (AMS) process, the FAA routinely examines current and projected needs within the NAS, with the goal of defining requirements to meet identified needs. This budget line item provides, on a recurring basis, the means to independently investigate the particulars of selected programs (service or system) or technologies. Such investigations assist in determining and selecting only those programs or technologies best suited to advance overall NAS system efficiency.

Agency Outputs: Activities funded by this budget line item include:

- Simulation
- Human factors
- Procedure development
- Performance definition
- Impact analysis
- Workload analysis
- Hazard analysis
- NAS architecture development

Specific FY02 programs include:

- Define and conduct requirements activities in support of developmental programs
  - Develop a Requirement Evaluation Plan in order to resolve a number of functional and performance requirements issues. The goal is to incorporate developmental programs into the AMS.
- Develop ARS En Route requirements for the NAS Design Tool.

  and assumptions, status and progress of in-
  - Prepare and validate an integrated set of future Air Traffic Services (ATS) en route domain requirements and a roadmap for implementing those requirements—to be incorporated into the NAS Design Tool.
- Maximize value of En Route investments
  - Develop a detailed Results Chain for En Route services.
  - Define investment packages containing necessary and sufficient initiatives to produce a meaningful end-user benefit.
  - Prepare an En Route services strategy paper containing a set of Value Cases for each investment package considered.
  - Provide a plan to manage the realization of benefits.
- Evaluate use of Collaborative Convective Forecast Product (CCFP) as a tool within the Collaborative Decision Making (CDM) program
  - Monitor and assist in the development of CCFP into a 24-hour-a-day program.
  - Evaluate the effectiveness and utilization of CCFP during previous poor weather sessions.
  - Develop an overall aviation weather telecommunications strategy and mission needs analysis.
- Support requirements definition and development of research demonstration program for the Traffic Management Units (TMU)
  - Develop, coordinate and provide oversight of research demonstration programs required by the TMUs

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Developed a four-part Results Chain that elaborates a strategy for sustaining and enhancing En Route services.
- Completed two Value Plots that illustrate the relative value of investments contemplated to sustain and enhance En Route services.
- Developed a Benefits Register that tracks achievement of benefits, management of risks

  vestment packages.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Prepare oral and written findings on efforts to prepare and validate future En Route domain requirements.
- Complete an En Route services strategy paper that informs decision makers of choices available to them.
- Develop a Governance Process – a sequence of investment reviews that report on the progress of investments, review assumptions and risks, and achievement of expected benefits.
- Evaluate use of CCFP within the overall Collaborative Decision Making program—including development of real-time verification statistics.
- Develop, coordinate, and provide oversight of the Traffic Management Unit research demonstration program.

FY 2002 PROGRAM REQUEST: A major key to maintaining objective, integrated NAS requirements development is a reliable, sustainable funding source that allows critical analyses of selected developmental systems—those systems that provide both the greatest potential payoffs for NAS system efficiency and the greatest risk of failure. The requested funding will allow investigations that will increase the probability of system success and identify factors and situations that require solutions before development begins.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$0
FY 2001 Enacted	2,900
FY 2002 Request	3,000
Out-Year Planning Levels (FY 2003-2006)	12,600
Total	$18,500

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
NAS Requirements	0	0	0	2,900	3,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**2,900**	**3,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	2,900	3,000
Total	**0**	**0**	**0**	**2,900**	**3,000**

NAS Requirements Development Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Define and Conduct Requirements Activities in Support of RE&D Activities	$1,375	◆	◇	◇	◇	◇	◇
Develop ARS En Route Requirements for NAS Design Tools	$225	◆	◇	◇			
Maximize Value of En Route Investments	$100	◆	◇	◇			
Evaluate Use of Collaborative Convective Forecast Product (CCFP) within the Collaborative Decision Making (CDM) Program	$675	◆	◇	◇	◇	◇	
Support Requirements Definition and Development of Research Demonstration Program for Traffic Management Unit (TMU)	$625	◆	◇	◇	◇	◇	
Total Budget Authority	$3,000	$2,900	$3,000	$3,000	$3,000	$3,000	$3,600

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

A04a Weather Program:

GOALS:

Intended Outcomes: The FAA intends to prothat are more accurate, accessible, and efficient than existing services. These upgrades will enhance flight safety, increase system capacity, improve flight efficiency, reduce air traffic controller and pilot workload, improve flight planning, increase productivity, and enhance situational awareness.

As required by the Federal Aviation Act of 1958, as amended, the FAA cooperates with the Department of Commerce in promoting and developing meteorological science, and in fostering support of research projects through the use of private and governmental research facilities. These duties are further amplified by recommendations contained in the National Aviation Weather Initiatives (1999), prepared by the Joint Action Group for Aviation Weather for the National Aviation Weather Program Council of the Office of the Federal Coordinator for Meteorology, and the final report of the Weather Joint Services Implementation Team (2000).

The weather program directly supports FAA Strategic Goal #1 in the performance area of Safety: "Through research, identify methods that, when implemented would reduce the fatal accident rate, due to weather" and Goal #2, Efficiency – reducing system delays, through development of weather dependent wake turbulence spacing standards for aircraft.

The weather program supports the FAA's policy of focusing its research, development, and acquisition on "products that will improve the safety and efficiency of the Air Traffic System," and it also directly supports the agency's "Safer Skies" initiatives.

This weather R,E&D program, in collaboration with National Weather Service (NWS) programs, produces weather algorithms (technology), more accurate and rapid forecasting and dissemination of forecasts (delivery) enhanced intuitive capability for aviation decision makers, and supports the development of aviation weather instructional material (education).

Agency Outputs: The weather program focuses on conducting applied research to solve operational problems through the development of new and improved weather algorithms and more efficient wake turbulence standards and procedures. The weather algorithms, are being developed for implementation on appropriate National Airspace System (NAS) platforms (including the weather and radar processor, and the integrated terminal weather system) and on NWS systems and continue to be transferred to private weather service companies in support of the NAS. This transfer of technology enables these companies to derive specialized aviation weather products from FAA research efforts. Algorithm development provides capabilities for dissemination to aviation weather users in support of air traffic control automation tools including:

- Depiction of current and forecasted in-flight icing areas to enhance safety, airspace efficiency, and aircraft utilization.
- Interactive data assimilation, editing and forecast tools to improve aviation advisories and forecasts issued by the NWS.
- Location, timing, and severity of convective weather hazards to improve flight safety and enhance capacity.
- Depiction of current and forecasted precipitation type and rate to enhance safety and efficiency in the terminal area.
- Short-term forecasts and prediction of ceiling and visibility in the terminal area for enhanced capacity
- In-situ and remote detection and forecast of enroute turbulence including clear air.

In addition, the weather program is conducting wake turbulence research to reduce airport delays. The goal is to adapt NASA Aircraft Vortex Sensing System (AVOSS) technology for weather dependent wake turbulence spacing with an initial focus on safety and capacity initiatives for closely spaced parallel runways.

Customer/Stakeholder Involvement: The weather research priorities and plans are consistent with user needs. The program works in concert with the Aviation Weather Directorate

(ARW), to derive research projects and priorities from the interagency National Aviation Weather Initiatives (1999), merged with other NAS drivers, such as "Safer Skies," Freeflight implementation and the NAS operational concept documents. The weather program continually revalidates these priorities and plans by giving briefings in public forums such as the 2000 National Business Aircraft Association conference to the Friends/Partners in Aviation Weather Forum.

The weather program has also analyzed aviation weather service users' needs and requirements found in the Aviation Safety Action Plan. Additionally, it has addressed industry recommendations and requirements found in several related documents and publications.

Accomplishments: The following represent major accomplishments of the weather program:

- Rapidly updated cycle analyses and forecast capabilities to provide more accurate and higher resolution upper winds, temperature, and precipitation data. Use of more accurate data on hazardous weather and jet streams has reduced flight times and/or flight delays.
- Issued the first-ever forecast of freezing precipitation aloft at the aviation weather center in Kansas City in response to FAA-proposed rulemaking for turboprops flying into conditions conducive to in-flight icing. These forecasts have increased airspace efficiency, aircraft utilization, and safety, especially for commuter aircraft.
- Commenced flight test of humidity sensor on United Parcel Service (UPS) aircraft, as part of the Water Vapor Sensing System (WVSS) program, leveraged with NOAA. The availability of detailed water vapor data in real time will be utilized to make more accurate in-flight icing, ceiling, and visibility forecasts.
- Completed upgrades to Next-Generation Weather Radar (NEXRAD) algorithms, storm cell identification and tracking, hail detection, and mesocyclone and tornado detection (leveraged with NWS). These upgrades have enabled better definition of location, timing, and severity of convective weather hazards resulting in enhanced flight safety and capacity.
- Completed convective storm growth and decay field tests in Dallas and Orlando. This research is resulting in the accurate short-term prediction of the initiation, growth, and decay of storm cells as it is providing operational benefit at the above two sites. It is enhancing safety and capacity by improving aircraft avoidance of hazardous weather, resulting in enhanced strategic and tactical flow management planning, allowing more effective routing of traffic to/from airports and runways.
- Transferred Weather Support to Deicing Decision Making (WSDDM) system technology to a commercial weather provider to provide ground deicing decision making information to airlines, airports and cities. WSDDM system information has resulted in increased safety (at time of takeoff) cost savings in use of deicing fluids/associated equipment/ personnel, and efficiencies in runway and off-airport plowing/departures/arrivals. Awarded 1999 Government Technology Leadership Award.
- Implemented initial operating capability of the Aviation Gridded Forecast System (AGFS) at the NWS, providing an aviation specific weather database for the aviation community and user access to this data via the Aviation Digital Data Service (ADDS). The ADDS flight path tool depicting vertical cross sections of weather along user-specified flight routes is providing benefit to users especially general aviation. Awarded 2000 Government Technology Leadership Award.
- Installed a wake turbulence monitoring system at San Francisco International Airport to support the Simultaneous Offset Instrument Approach (SOIA) safety and capacity initiative.

R&D Partnerships: In addition to its partnership with the FAA's Aviation Weather Directorate, weather research activities are closely coordinated and leveraged with industry, academia, and other government agencies. This is done directly through interagency agreements, university grants and Memorandums of Agree-

ment (MOAs). Principal partners include the National Center for Atmospheric Research; NOAA's Forecast Systems Laboratory; the Environmental Technology Laboratory and National Severe Storms Laboratory; Massachusetts Institute of Technology's Lincoln Laboratory; NWS's Aviation Weather Center and Environmental Modeling Center; the Center for Wind, Ice, and Fog Research at the Mount Washington Observatory; NASA Dryden, Langley and Glenn; the Office of Naval Research; the U.S. Army Cold Regions Research and Engineering Laboratory; UPS; and facilities of several universities, airlines, port authorities, and cities.

Research results are transferred to the private sector via cooperative research and development agreements with GTE, Kavouras, WSI, Harris, AccuWeather, Jeppesen, Sonalyst, and Radian.

Wake turbulence activities are conducted jointly or closely coordinated with NASA, the Volpe Center, MIT Lincoln Labs, MITRE, and international research efforts.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Obtained FAA approval for an icing diagnosis algorithm for operational NAS use.
- Commenced inclusion of turbulence in-situ data into forecast models.
- Transfered ADDS to AWC for 24/7 operations.
- Obtained FAA approval for an initial national convective weather product for operational NAS use.
- Commenced development of 1-2 hour precipitation forecast.
- Conducted evaluation of marine stratus burn-off forecast at San Francisco International Airport (SFO).
- Delivered damaging downburst algorithm to Radar Operations Center (ROC).
- Implemented Phase I wind data & dissemination system at Juneau Airport.
- Commenced Phase I development of oceanic convective nowcasting products.
- Commenced analysis and planning for the National Ceiling and Visibility (C&V) Program.
- Developed delay reducing wake turbulence procedures and standards for San Francisco International Airport.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Implement icing intensity and threat fields into icing potential products.
- Implement cloud display forecast via ADDS flight path tool.
- Implement boundary layer data into Integrated Terminal Weather System (ITWS) prototypes.
- Complete in-situ based turbulence detection product evaluation.
- Implement 1-2 hour marine stratus burn-off forecast for San Francisco International Airport.
- Deliver a storm tracker algorithm to ROC.
- Implement a certified wind system at Juneau Airport.
- Complete analysis of Phase I demo and benefits of Oceanic Convective Nowcasting manual products.
- Develop an instrument flight rules (IFR) product for the Aviation Weather Center (AWC) as part of the National C&V program.
- Complete implementation of a wake turbulence monitoring system at San Francisco.
- Initiate wake monitoring system at Newark to support Precision Runway Monitoring (PRM) operations.

FY 2002 PROGRAM REQUEST:

- Develop new algorithms for improved forecasts of freezing drizzle aloft.
- Continue to develop automated data analysis and assimilation techniques.
- Transition weather research products to operations in the NWS, the FAA, and industry automation and weather systems.
- Develop oceanic convective nowcasting products.

- Conduct wake turbulence research to enable terminal procedures for closely spaced, parallel runway operations at major airports.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 202,019
FY 2001 Enacted	24,751
FY 2002 Request	28,368
Out-Year Planning Levels (FY 2003-2006)	118,038
Total	$ 373,176

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Weather Program	14,500	17,836	18,635	23,960	26,406
Personnel Costs	664	817	629	705	1,506
Other In-house Costs	136	31	36	86	456
Total	**15,300**	**18,684**	**19,300**	**24,751**	**28,368**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	15,300	18,684	19,300	24,751	28,368
Development (includes prototypes)	0	0	0	0	0
Total	**15,300**	**18,684**	**19,300**	**24,751**	**28,368**

A04a - Weather Program Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
041-110 Aviation Weather Analysis and Forecasting							
In-Flight Icing	$2,068						
Icing Diagnosis Algorithm Approved by FAA for Operational NAS Use		◆					
Implement Icing Intensity & Threat Fields into Icing Potential Products			◇				
Implement Icing Algorithms for Data-Poor Regions				◇			
Test Airborne Detection Systems							◇
Storm Growth and Decay	$2,964						
Initial National Product Approved by FAA for Op. NAS use Product		◆					
Implement Boundary Layer Data into ITWS Prototype Forecast			◇				
Complete Demo of Growth & Decay Algorithms with ATC Users				◇			
NEXRAD Algorithms	$1,500						
Deliver Damaging Downburst Algorithm to Op. Spt. Facility		◆					
Deliver Storm Tracker Algorithm to OP. Spt. Facility			◇				
Deliver Storm Tracker Algorithm to OP. Spt. Facility							◇
Aviation Gridded Forecast System	$1,870						
Transfer ADDS to AWC for 24/7 operations		◆					
Implement Cloud Display fc via ADDS Flight Path Tool			◇				
Implement at AWC Capability to Interactively Generate Collaborative Products				◇			
Model Development and Enhancement	$1,659						
Commence Development of Weather Research & Forecasting Model (WRF)		◆					
Winter Weather Research	$1,550						
Commence Development of 1-2 hr. Snowfall Forecast		◆					
Develop Techniques to Detect/Forecast Precip. Type/rate			◇	◇			
Ceiling and Visibility	$750						
Evaluate Performance of 1-2 hr. Burn-Off Forecast at SFO		◆					
Implement a 1-2 hr. Marine Stratus Burn-Off Forecast at SFO			◇				
Juneau	$6,700						
Implement Phase 1 Wind Data Ingest & Dissemination Sys.		◆					
Turbulence	$2,749						
Commence Inclusion of In-Situ Turbulence Data into Models		◆					
Complete In-Situation Based Detection Product Evaluation			◇				
Airborne Humidity Sensor	$501						
Complete Sensor Evaluation/NOAA/FAA Decision on Utility							
National Ceiling and Visibility	$1,956						
Commence Analysis and Planning		◆					
Develop IFR product for the AWC			◇	◇			
Oceanic Convective Nowcasting	$1,139						
Commence Phase 1 Development of Manual Products		◆					
Commence Phase 1 Development of Manual Products			◇				
Wake Turbulence	$1,000						
Support Safety/Capacity Initiative at High Priority Airports				◇			
Adapt NASA AVOSS Technology for FAA Operational Use					◇		
Personnel and Other In-House Costs	$1,962						
Total Budget Authority	**$28,368**	**$24,751**	**$28,368**	**$28,827**	**$29,229**	**$29,807**	**$30,175**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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